ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF PREVENTION, PESTICIDES, AND TOXIC SUBSTANCES

Memorandum

Date: November 18, 2010

Subject: Ecological Hazards and Risk Assessment for Copper Pyrithione

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Petition No(s).: NA	Regulatory Action: Product Registration - Section 3
Risk Assess Type: Single Chemical/Ecological	Case No(s).: NA
TXR No.: NA	CAS No(s): 14915-37-8
MRID No(s).: NA	40 CFR: NA

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Copper pyrithione is a new active ingredient proposed for use in antifoulant paints for watercraft. Due to potential exposure of aquatic organisms from leaching of copper pyrithione from boat and ship hulls into freshwater and saltwater bodies, a risk assessment has been conducted for the active ingredient.

In accordance with the new chemical screen for copper pyrithione (June 2, 2004) and after review of the available environmental fate data (*Environmental Fate Science Chapter on Zinc Pyrithione (Zinc Omadine®) and Proposed Bridging to Copper Pyrithione*, J. Breithaupt, RASSB/AD, November 17, 2010), a full ecotoxicity data set for copper pyrithione is not being required. The fate and effects data submitted by the registrant for copper pyrithione are considered sufficiently similar to the existing data for zinc pyrithione to allow bridging between these two pyrithione compounds.

Predictions of exposure (EECs) for the risk assessment are based on MAM-PEC, a European model developed to predict concentrations of antifoulant pesticides in aquatic environments (e. g., marinas, harbors, surrounding areas). MAM-PEC scenarios modeled for copper pyrithione include inland and coastal marinas and an estuarine harbor. EECs are calculated for the water column and sediment within each setting. RASSB's hazard and risk conclusions are summarized below and presented in more detail in the attached ecological risk assessment.

Hazard and Risk Conclusions:

- Copper pyrithione is very highly toxic to freshwater and saltwater fish and aquatic invertebrates and slightly to moderately toxic to terrestrial animals; based on acute toxicity, a precautionary hazards statement is required for aquatic organisms (see label requirements below)

- Two freshwater (inland) and two saltwater (coastal) scenarios were modeled using exposure predictions from MAM-PEC. The following LOCs are exceeded for acute risk to aquatic organisms inhabiting the water column:

	LOCs exceeded	
Scenario	**Listed spp.[1]**	**Non-listed spp.**
Inland Marina:	Fish, acute Aquatic invertebrates, acute	None
Inland Small Marina:	Fish, acute Aquatic invertebrates, acute	Fish, acute
Coastal Marina:	Aquatic invertebrates, acute	None
Coastal Harbor:	None	None

For the freshwater scenarios, 135 listed fish species or populations and more than 100 listed species of aquatic invertebrates (e. g., clams, snails, crustaceans) are potentially at risk (http://www.fws.gov/endangered/species/us-species.html).

[1] Federally designated as endangered or threatened

For the estuarine/marine scenarios, four listed species are potentially at risk. These species include the white abalone (*Haliotis sorenseni*) and black abalone (*H. cracherodii*) in 13 counties off the coast of southern California; and the elkhorn coral (*Acropora palmate*) and staghorn coral (*A. cervicornis*) in coastal Miami-Dade and Monroe counties in southern Florida and in coastal areas of Puerto Rico and the Virgin Islands.

- The chronic LOC is not exceeded for any taxa for any scenario
- The LOC is not exceed for listed and non-listed aquatic plants for any scenario
- Based on low predicted concentrations in sediment after one year in relation to the sediment-based toxicity of copper pyrithione to freshwater and marine amphipods, minimal risks are presumed for exposure to sediment containing copper pyrithione leached from watercraft hulls
- Two degradates tested are only slightly to practically nontoxic to aquatic plants and animals
- Copper pyrithione is not presumed to pose risks to terrestrial animals, due to its low toxicity to birds and mammals and little potential for bioaccumulation

Label requirements:

All product labels must have the following **ENVIRONMENTAL HAZARDS** statement:

"This pesticide is toxic to fish and other aquatic organisms. Do not apply directly to water by cleaning of equipment or disposal of wastes. Do not allow chips and dust generated during paint removal to enter water. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authorities are notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA."

Required guideline studies:

No additional guideline studies are required at this time. However, when additional information becomes available (see below) to enable a more refined risk assessment for U. S. waters, the following study may be required:

Fish life cycle (850.1500); reserved

Additional information needed:

Additional information is needed to better refine the risk assessment for U. S. harbors and marinas. Such information includes but is not limited to the following:

- Dimensions of marinas and harbors
- Number and sizes of watercraft in the facility, including seasonal and geographical variations
- Environmental inputs including tides and currents, water temperature, salinity, pH, sediment density, and others

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Ecological Hazard and Environment Risk Assessment
Copper Pyrithione

Copper pyrithione (also referred to as copper omadine) is a new chemical intended for use as an antifoulant paint on watercraft. The MUP is COPPER OMADINE POWDER AF (copper 2-pyridinethiol-1-oxide, 98%). The end-use product is intended for below-waterline application to fiberglass, wood and properly primed metal boat hulls and parts in fresh, salt and brackish waters. It is not for use on aluminum hulls.

Both a hazards and risk assessment have been conducted. A risk assessment is required, because the intended use of copper pyrithione as an antifoulant coating will result in exposure of aquatic organisms due to leaching of the active ingredient into the aquatic environment. The hazards assessment is used to meet current labeling requirements for precautionary statements and to determine toxicity endpoints for the ecological risk assessment.

Ecological Hazards Assessment

The toxicity endpoints used in OPP's assessments are obtained from guideline toxicity studies conducted for wildlife, aquatic organisms, and plants (40 CFR §158). Guideline studies are required to provide acute and reproductive/chronic measures of effect for one or more test species in several taxonomic groups. Some studies are only required on a case-by-case basis, depending on factors such as use patterns and environmental fate characteristics.

The full complement of acute and chronic ecotoxicity data available for copper pyrithione and zinc pyrithione and two degradates (pyridine sulfonic acid and pyrithione sulfonic acid) are presented in Appendix A. The most sensitive species in each taxa/group is used in the assessment. Those data are tabulated below (Table 1). The data characterize copper pyrithione as being highly to very highly toxic freshwater and saltwater fish and invertebrates and slightly to moderately toxic to birds and mammals. A precautionary hazards label statement is required for aquatic organisms.

Table 1. Ecotoxicity Data Used in the Hazard and Risk Assessment

Category/ Species	**Measurement endpoint**	**Toxicity endpoint**	**Toxicity category**
Birds:			
Northern bobwhite	acute LD50	60 mg ai/kg bw	moderately toxic
	dietary LC50	1063 ppm ai	slightly toxic
Mammals:			
Laboratory rat	acute LD50	630 mg ai/kg bw (♂) 460 mg ai/kg bw (♀)	slightly to moderately toxic
Freshwater fish:			

Fathead minnow	acute LC50	2.6 µg ai/L	very highly toxic
	chronic NOEC	0.98 µg ai/L	
Freshwater invertebrates:			
Waterflea	acute EC50	8.2 µg ai/L	very highly toxic
	chronic NOEC	2.7 µg ai/L	
Estuarine/marine fish:			
Sheepshead minnow	acute LC50	400 µg ai/L	highly toxic
	chronic NOEC	no data	
Estuarine/marine invertebrates:			
Mysid shrimp	acute LC50	4.7 µg ai/L	very highly toxic
	chronic NOEC	2.2 µg ai/L	
Aquatic plants:			
Duckweed	EC50	8.8 µg ai/L	n/a
	NOEC	4.0 µg ai/L	
Freshwater diatom	EC50	2.6 µg ai/L	n/a
Saltwater diatom	EC50	0.65 µg ai/L	n/a
Sediment toxicity:			
Freshwater amphipod	EC50 or LC50	2.1 mg/kg dry wt	n/a
Saltwater amphipod	EC50 or LC50	<1.08 mg/kg dry wt	n/a

The toxicity data for the two degradates tested are presented in Tables 5A, 6A, and 8A in Appendix A. The degradates are only slightly to practically nontoxic to aquatic organisms.

Ecological Risk Assessment and Characterization

Risk assessment and characterization integrates exposure and toxicity information to evaluate the potential for adverse ecological effects. Risk quotients (RQs) are determined for each taxa or ecological group by comparing exposure estimates (Estimated Environmental Concentrations, EECs) to the available acute and chronic ecotoxicity values, where:

RQ = Exposure estimate (EEC) / Toxicity value

RQs are compared to OPP's levels of concern (LOCs). Exceedance of an LOC indicates a potential for acute or chronic adverse effects on nontarget organisms and identifies a need for regulatory action to mitigate risk. LOCs currently address the following risk presumptions:

acute:	regulatory action may be warranted to reduce or preclude acute exposure
acute, listed species:	additional regulatory action may be warranted to protect listed (i.e., endangered or threatened) species

chronic:	regulatory action may be needed to reduce or preclude chronic exposure

The LOCs for the various risk presumptions are listed below for terrestrial and aquatic animals and plants:

	Aquatic Animals	Terrestrial Animals	Plants
Acute:	0.5	0.5	1
Acute, listed species:	0.05	0.1	1
Chronic:	1	1	n/a

The following toxicity endpoints are used as inputs to the RQ method for expressing risk:

Aquatic Animals

Acute:	Lowest tested EC50 or LC50 for freshwater fish and invertebrates and estuarine/marine fish and invertebrates
Chronic:	Lowest NOEC for freshwater fish and invertebrates and estuarine/marine fish and invertebrates (early life-stage or full life-cycle tests)

Terrestrial Animals

Avian acute:	Lowest LD50 (single oral dose) and LC50 (subacute dietary)
Avian chronic:	Lowest NOEC (21-week avian reproduction test)
Mammalian acute:	Lowest LD50 from single oral dose test.
Mammalian chronic:	Lowest NOEC for two-generation reproduction test

Plants

Terrestrial:	Lowest EC25 values from both seedling emergence and vegetative vigor for both monocots and dicots
Terrestrial listed:	Lowest EC05 or NOEC for both seedling emergence and vegetative vigor for both monocots and dicots
Aquatic vascular and algae:	Lowest EC50
Aquatic vascular listed:	NOEC or EC05

When available, toxicity measures or other appropriate information from non-guideline studies or from the open literature also may be used to characterize and refine risks.

OPP generally uses computer simulation models to estimate exposure of aquatic organisms to an active ingredient. These models estimate EECs in surface waters and sediment using product-label information (e.g., treatment site, application rate, application method) and available environmental-fate data to determine how rapidly the pesticide degrades and its expected movement in environmental compartments. The model used in the current risk assessment is described in more detail in the **Aquatic Exposure Assessment** section.

For aquatic organisms, the following EECs are typically used to calculate the RQ for each taxa:

Fish

Acute: Instantaneous
Chronic: 60-day average

Invertebrates

Acute: Instantaneous
Chronic: 21-day average

Plants

Acute: Instantaneous
Chronic: Not applicable

Aquatic Exposure Assessment

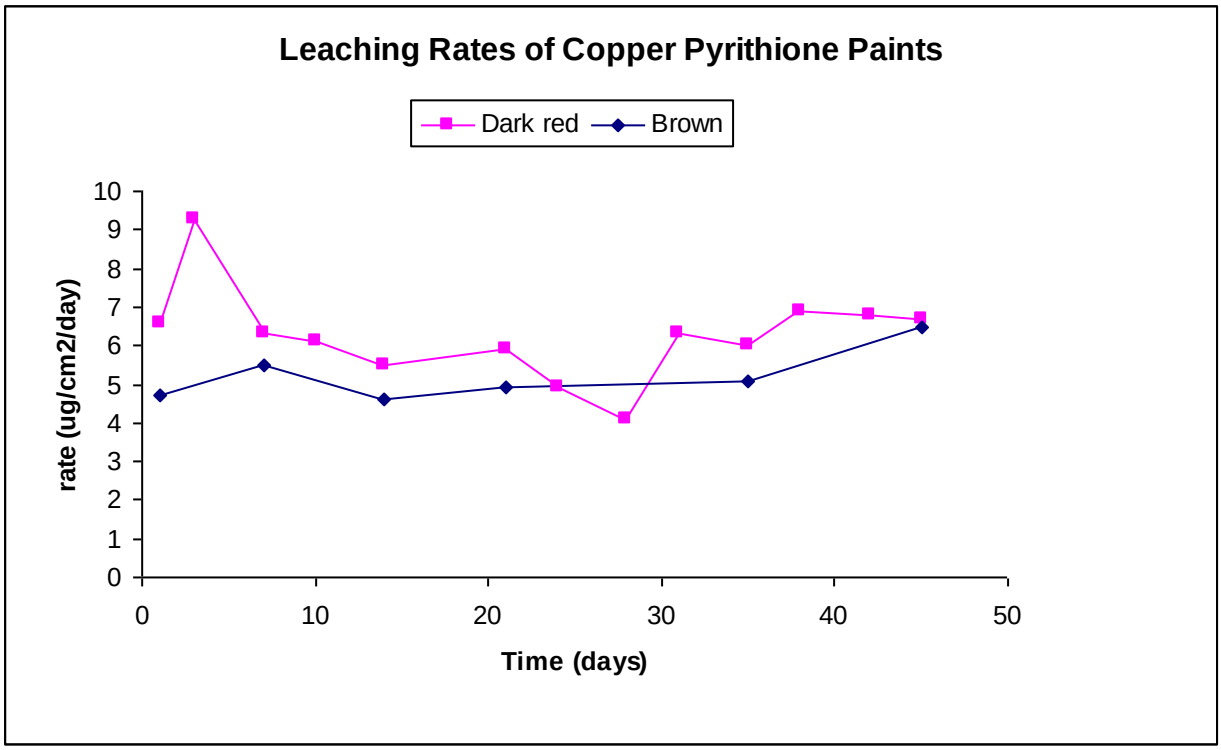
EECs in the water column and sediment are estimated using MAM-PEC (v. 2.0)[2,3]. The MAM-PEC model was developed by the Institute of Environmental Studies/IVM and Delft Hydraulics for the European Paint Makers Association to predict environmental concentrations of antifoulant paints/coatings in various marine environments (e.g., marinas, harbors, surrounding waters). The model accounts for a variety of emission factors (e.g., leaching rate, watercraft numbers and sizes, residence times, watercraft-hull underwater surface areas), compound-related properties and processes (e.g., Kd, Kow, Koc, volatilization, speciation, hydrolysis, photolysis, biodegradation), and environmental properties and processes (e.g. currents, tides, salinity, DOC, suspended matter load, port dimensions). The default scenarios in MAM-PEC allow the user to alter input values for the specific locality being assessed if data are available. For example, the dimensions of the default marina (see below) can be altered for the known dimensions of a

[2] van Hattum B., A.C Baart, and J.G. Boon. 2002. Computer model to generate predicted environmental concentrations (PECs) for antifouling products in the marine environment - 2nd ed. accompanying the release of Mam-Pec version 1.4, IVM Report (E-02/04), Institute for Environmental Studies, Vrije Universiteit, Amsterdam, Netherlands.

[3] OECD. 2005. Emission Scenario Document on Antifouling Products. OECD Environmental Health and Safety Publications, OECD Series on Emission Scenario Documents No. 13, ENV/JM/MONO(2005)8, Organisation for Economic Co-operation and Development, 166 pp.

specific marina, or to predict aquatic EECs for marinas of different sizes. The number and sizes of watercraft also can be changed, as well as the percentage of craft treated if actual usage information is obtained. With a few modifications (e. g., latitude, water temperature, salinity and tidal factors), RASSB is using the default scenarios provided by MAM-PEC for the current assessment of copper pyrithione. These scenarios can be further refined when additional information on the dimensions and physical and chemical properties of U. S. coastal and inland marinas and harbors become available.

The estimated leaching rate of copper pyrithione from painted hulls was determined from two leaching studies conducted by the registrant and submitted to and reviewed by RASSB. Maximum and average EECs are predicted for the water column and over time in sediment, both within the marina or harbor and in the surrounding waters. EECs are generated for the highest leaching rates (9.3 μg/cm^2/day, dark red formulation; 6.5 μg/cm^2/day, brown formulation) for all scenarios. For each scenario, in the absence of any usage information, it is assumed that 100% of the craft are treated. If usage information becomes available, the scenarios can be refined to reflect that information. The EECs generated by MAM-PEC are used for both acute and chronic exposure. The leaching rate varied little over the 45-day study period in both studies (MRIDs 471077-09 and 471077-10) as illustrated below.



The inland (freshwater) and coastal (saltwater) marina and harbor scenarios used in this assessment are briefly described below. Details of the specific runs, including all input values and predicted water-column and sediment EECs are provided in Appendix B. Further descriptions of the MAM-PEC model default scenarios are provided in the OECD (2005) *Emission Scenario Document on Antifouling Products*.

Inland Marina

MAM-PEC scenario: default estuarine harbor (no tidal factors, minimal salinity)
Dimensions: 400 x 400 m, 3.5 m deep
No. craft at berth: 299 (10-50 m in length)
Underwater area of individual craft: 22.5 m^2
See Appendix B1a,b for additional specifications on this scenario

Inland Small Marina

MAM-PEC scenario: modified default Swiss marina scenario from OECD (2005)
Dimensions: 100 x 100 m, 2 m deep
No. craft at berth: 75 ($\leq$10 m in length)
Underwater area of individual craft: 10 m^2
See Appendix B2a,b for additional specifications on this scenario

Coastal Marina

MAM-PEC scenario: default marina
Dimensions: 400 x 400 m, 3.5 m deep
No. craft at berth: 299 (10-50 m in length)
Underwater area of individual craft: 22.5 m^2
See Appendix B3a,b for additional specifications on this scenario

Coastal Harbor

MAM-PEC scenario: default estuarine harbor
Dimensions: 1000 x 5000 m, 15 m deep
No. craft at berth: 24 (50-100 m to 250-300 m in length)
Underwater area of individual craft: 450 to 14,814 m^2
See Appendix B4a,b for additional specifications on this scenario

MAM-PEC predicted EECs in the water column are presented in Table 2 for the inland scenarios and in Table 3 for the coastal scenarios. Table 4 presents the MAM-PEC predicted maximum sediment concentrations after one year in the marina or harbor and in the surrounding waters. Average predicted sediment concentrations did not change after two, five, and 10 years (see Appendix B). These predictions are further discussed in the **Aquatic Risk Assessment** section entitled **Invertebrates Exposed to Contaminated Sediments, Acute**.

Table 2. MAM-PEC Predicted Water-column EECs for Inland Marinas and Surrounding Waters

Leaching rate ($\mu g/cm^2/day$)	Marina or Harbor EEC (µg/L)		Surrounding-water EEC (µg/L)	
	max.	avg.	max.	avg.
Inland Marina:				
9.3	0.409	0.269	0.024	0.001
6.5	0.286	0.188	0.017	<0.001
Inland Small Marina:				
9.3	1.560	0.981	0.062	0.006
6.5	1.090	0.686	0.043	0.004

Table 3. MAM-PEC Predicted Water-column EECs for Coastal Marinas and Harbors and Surrounding Waters

Leaching rate ($\mu g/cm^2/day$)	Marina or Harbor EEC (µg/L)		Surrounding-water EEC (µg/L)	
	max.	avg.	max.	avg.
Coastal Marina:				
9.3	0.418	0.276	0.024	0.001
6.5	0.286	0.188	0.017	<0.001
Coastal Harbor:				
9.3	0.097	0.048	0.016	0.003
6.5	0.068	0.033	0.011	0.002

Table 4. MAM-PEC Predicted Maximum Sediment Concentrations for Inland and Coastal Marinas and Harbors

Environment	Leaching rate (µg/cm^2/day)	Max. concentration (µg/g dry wt) after 1 year	
		marina or harbor	surrounding waters
Inland Marina	9.3	4.84E-07	2.82E-08
	6.5	3.38E-07	1.97E-08
Inland Small Marina	9.3	1.84E-06	7.34E-08
	6.5	1.29E-06	5.13E-08
Coastal Marina	9.3	2.48E-06	1.46E-07
	6.5	1.69E-06	9.86E-08
Coastal Harbor	9.3	5.72E-07	9.34E-08
	6.5	4.00E-07	6.53E-08

Aquatic Risk Assessment

Freshwater Fish and Invertebrates Exposed in the Water Column, Acute

RQs based on acute toxicity to the most sensitive freshwater fish species (fathead minnow) and invertebrate species (waterflea) exceed the acute LOC for listed (e.g., threatened and endangered) species in the inland marina scenarios, even when RQs are based on average EECs (Tables 5 and 6). Non-listed fish also are at risk from high exposure in small marinas. No LOC is exceeded for either fish or aquatic invertebrates in the waters surrounding inland marinas.

Table 5. Acute Risk Quotients for Freshwater Fish and Invertebrates Exposed in the Water Column of an Inland Marina (400 x 400 m, 3.5 m deep) and Surrounding Waters

Site/ Taxa	Leaching rate (µg/cm^2/day)	EEC (µg ai/L)		LC50/EC50 (µg ai/L)	Acute RQ	
		max.	avg		max.	avg
Inland Marina:						
Fish	9.3	0.409	0.269	2.6	**0.16***	**0.10***
	6.5	0.286	0.188		**0.11***	**0.07***
Invertebrates	9.3	0.409	0.269	8.2	**0.05***	0.03
	6.5	0.286	0.188		0.03	0.02
Surrounding waters:						
Fish	9.3	0.024	0.001	2.6	<0.01	<0.01

Site/ Taxa	Leaching rate (µg/cm^2/day)	EEC (µg ai/L)		LC50/EC50 (µg ai/L)	Acute RQ	
		max.	avg		max.	avg
	6.5	0.017	<0.001		<0.01	<0.01
Invertebrates	9.3	0.024	0.001	8.2	<0.01	<0.01
	6.5	0.017	<0.001		<0.01	<0.01

***** exceeds the LOC for listed species (RQ ≥0.05)

Table 6. Acute Risk Quotients for Freshwater Fish and Invertebrates Exposed in the Water Column of an Inland Small Marina (100 x 100 m, 2 m deep)

Site/ Taxa	Leaching rate (µg/cm^2/day)	EEC (µg ai/L)		LC50/EC50 (µg ai/L)	Acute RQ	
		max.	avg		max.	avg
Inland Small Marina:						
Fish	9.3	1.560	0.981	2.6	**0.60****	**0.34***
	6.5	1.090	0.686		**0.42***	**0.26***
Invertebrates	9.3	1.560	0.981	8.2	**0.19***	**0.12***
	6.5	1.090	0.686		**0.13***	**0.08***
Surrounding waters:						
Fish	9.3	0.062	0.006	2.6	0.02	<0.01
	6.5	0.043	0.004		0.02	<0.01
Invertebrates	9.3	0.062	0.006	8.2	<0.01	<0.01
	6.5	0.043	0.004		<0.01	<0.01

****** exceeds the LOC for listed (RQ ≥0.05) and non-listed (RQ ≥0.5) species
***** exceeds the LOC for listed species

Estuarine/marine Fish and Invertebrates Exposed in the Water Column, Acute

RQs based on acute toxicity to the sheepshead minnow and mysid shrimp and maximum and average EECs in the water column exceed the acute LOC only for listed invertebrates in the coastal marina scenario (Table 7). No LOC is exceeded for the harbor scenario, even at predicted maximum exposure (Table 8), or in the waters surrounding the marina.

Table 7. Acute Risk Quotients for Saltwater Fish and Invertebrates Exposed in the Water Column of a Coastal Marina and Surrounding Waters

Site/ Taxa	Leaching rate ($\mu g/cm^2/day$)	EEC (µg ai/L)		LC50 (µg ai/L)	Acute RQ	
		max.	avg		max.	avg
Coastal Marina:						
Fish	9.3	0.418	0.276	400	<0.01	<0.01
	6.5	0.286	0.188		<0.01	<0.01
Invertebrates	9.3	0.418	0.276	4.7	**0.09***	**0.06***
	6.5	0.286	0.188		**0.06***	0.04
Surrounding waters:						
Fish	9.3	0.024	0.001	400	<0.01	<0.01
	6.5	0.017	<0.001		<0.01	<0.01
Invertebrates	9.3	0.024	0.001	4.7	<0.01	<0.01
	6.5	0.017	<0.001		<0.01	<0.01

*****exceeds the LOC for listed species (RQ $\geq$0.05)

Table 8. Acute Risk Quotients for Saltwater Fish and Invertebrates Exposed in the Water Column of a Coastal Harbor and Surrounding Waters

Site/ Taxa	Leaching rate ($\mu g/cm^2/day$)	EEC (µg ai/L)		LC50 (µg ai/L)	Acute RQ	
		max.	avg		max.	avg
Coastal Harbor:						
Fish	9.3	0.097	0.048	400	<0.01	<0.01
	6.5	0.068	0.033		<0.01	<0.01
Invertebrates	9.3	0.097	0.048	4.7	0.02	0.01
	6.5	0.068	0.033		0.01	<0.01
Surrounding waters:						
Fish	9.3	0.016	0.003	400	<0.01	<0.01
	6.5	0.011	0.002		<0.01	<0.01
Invertebrates	9.3	0.016	0.003	4.7	<0.01	<0.01

Site/ Taxa	Leaching rate (µg/cm^2/day)	EEC (µg ai/L)		LC50 (µg ai/L)	Acute RQ	
		max.	avg		max.	avg
	6.5	0.011	0.002		<0.01	<0.01

Aquatic Organisms Exposed in the Water Column, Chronic

No chronic LOC is exceeded for any of the inland or coastal scenarios, even at maximum exposure (i. e., highest leaching rate, highest predicted EECs; Tables 9-12). Therefore, chronic risk to freshwater and saltwater fish and invertebrates is considered to be minimal for the proposed antifoulant use of copper pyrithione.

Table 9. Chronic Risk Quotients for Freshwater Fish and Invertebrates Exposed in the Water Column of an Inland Marina (400 x 400 m, 3.5 m deep) and Surrounding Waters

Site/ Taxa	Leaching rate (µg/cm^2/day)	EEC (µg ai/L)		NOEC (µg ai/L)	Chronic RQ	
		max.	avg		max.	avg
Inland Marina:						
Fish	9.3	0.409	0.269	0.98	0.42	0.27
	6.5	0.286	0.188		0.29	0.19
Invertebrates	9.3	0.409	0.269	2.7	0.15	0.10
	6.5	0.286	0.188		0.10	0.07
Surrounding waters:						
Fish	9.3	0.024	0.001	0.98	0.02	<0.01
	6.5	0.017	<0.001		0.02	<0.01
Invertebrates	9.3	0.024	0.001	2.7	<0.01	<0.01
	6.5	0.017	<0.001		<0.01	<0.01

Table 10. Chronic Risk Quotients for Freshwater Fish and Invertebrates Exposed in the Water Column of an Inland Small Marina (100 x 100 m, 2 m deep)

Site/ Taxa	Leaching rate (µg/cm^2/day)	EEC (µg ai/L)		NOEC (µg ai/L)	Chronic RQ	
		max.	avg		max.	avg
Inland Small Marina:						
Fish	9.3	1.560	0.981	0.98	**1.6***	**1.0***
	6.5	1.090	0.686		**1.1***	0.7
Invertebrates	9.3	1.560	0.981	2.7	0.6	0.36
	6.5	1.090	0.686		0.4	0.25
Surrounding waters:						
Fish	9.3	0.062	0.006	0.98	0.06	<0.01
	6.5	0.043	0.004		0.04	<0.01
Invertebrates	9.3	0.062	0.006	2.7	0.02	<0.01
	6.5	0.043	0.004		0.02	<0.01

***** exceeds the chronic LOC (RQ ≥1) for listed and nonlisted species

Table 11. Chronic Risk Quotients for Saltwater Invertebrates Exposed in the Water Column of a Coastal Marina and Surrounding Waters

Site/ Taxa	Leaching rate (µg/cm^2/day)	EEC (µg ai/L)		NOEC (µg ai/L)	Chronic RQ	
		max.	avg		max.	avg
Coastal Marina:						
Invertebrates	9.3	0.418	0.276	2.2	0.2	0.1
	6.5	0.286	0.188		0.1	<0.1
Surrounding waters:						
Invertebrates	9.3	0.024	0.001	2.2	<0.1	<0.1
	6.5	0.017	<0.001		<0.1	<0.1

Table 12. Chronic Risk Quotients for Saltwater Fish and Invertebrates Exposed in the Water Column of a Coastal Harbor and Surrounding Waters

Site/ Taxa	Leaching rate ($\mu g/cm^2/day$)	EEC (µg ai/L)		NOEC (µg ai/L)	Chronic RQ	
		max.	avg		max.	avg
Coastal Harbor:						
Invertebrates	9.3	0.097	0.048	2.2	<0.1	<0.1
	6.5	0.068	0.033		<0.1	<0.1
Surrounding waters:						
Invertebrates	9.3	0.016	0.003	2.2	<0.1	<0.1
	6.5	0.011	0.002		<0.1	<0.1

Invertebrates Exposed to Contaminated Sediments, Acute

Minimal risk is presumed for benthic organisms exposed to copper pyrithione in sediments of marinas or harbors. RQs based on the highest maximum sediment concentrations are several orders of magnitude below the LOC (Table 13). RQs based on average EECs and lower leaching rates would be even lower than those tabulated for the highest exposure scenarios. Some uncertainty exists for saltwater invertebrates, because a definitive toxicity value was not established. However, because the exposure values are exceedingly low, it seems highly unlikely that establishing the toxicity to saltwater invertebrates would lead to any exceedance of the LOC.

Table 13. Acute Risk Quotients for Freshwater and Saltwater Invertebrates Exposed to Contaminated Sediment in Inland and Coastal Marinas

Site/ Taxa	Leaching rate ($\mu g/cm^2/day$)	Max. EEC (µg/g dry wt)	Toxicity (µg/g dry wt)	Max. Acute RQ
Inland Small Marina:				
Freshwater amphipod	9.3	0.0000018	2.1	<<0.01
Coastal Marina:				
Saltwater amphipod	9.3	0.0000017	<1.08	<<0.01

It should be mentioned that MAM-PEC predicted sediment concentrations after 2, 5, and 10 years are the same as those predicted after one year. Those predictions are based solely on the

initial exposure at Day 0 and do not consider any subsequent copper pyrithione input into the aquatic environment. In fact, existing watercraft would be retreated, new craft may be treated, and other treated craft may be entering marinas. Therefore, sediment concentrations might actually increase over time, not remain constant, and this adds some uncertainty to the exposure and risk assessment.

Aquatic Plants

RQs for nonlisted species are presented in Table 14 for both freshwater and saltwater aquatic plants, based on the various exposure scenarios and the toxicity to duckweed (vascular sp.) and the most sensitive non-vascular species (algae or diatom). The LOC is not exceeded for vascular and non-vascular species in any inland or coastal scenario. The LOC for listed vascular species also is not exceeded for any scenario at maximum exposure (Table 15).

Table 14. Risk Quotients for Nonlisted Aquatic Plant Species (vascular and non-vascular) Exposed in the Water Column of Inland and Coastal Marinas and Harbors

Site/ Taxa	Leaching rate ($\mu g/cm^2/day$)	EEC (µg ai/L)		EC50 (µg ai/L)	RQ	
		max.	avg		max.	avg
Inland Marina:						
Vascular spp.	9.3	0.409	0.269	8.8	<0.1	<0.1
Non-vascular spp.		0.409	0.269	2.6	0.2	0.1
Inland Small Marina:						
Vascular spp.	9.3	1.560	0.981	8.8	0.2	0.1
	6.5	1.090	0.686		0.1	<0.1
Non-vascular spp.	9.3	1.560	0.981	2.6	0.6	0.4
	6.5	1.090	0.686		0.4	0.3
Coastal Marina:						
Vascular spp.	9.3	0.418	0.276	8.8	<0.1	<0.1
Non-vascular spp.		0.418	0.276	2.6	0.2	0.1
	6.5	0.286	0.188		0.1	<0.1
Coastal Harbor:						
Vascular spp.	9.3	0.097	0.048	8.8	<0.1	<0.1
Non-vascular spp.		0.068	0.033	2.6	<0.1	<0.1

Table 15. Risk Quotients for Listed Vascular Aquatic Plant Species Exposed in the Water Column of Inland and Coastal Marinas and Harbors

Site/ Taxa	Leaching rate ($\mu g/cm^2/day$)	EEC (µg ai/L)		NOEC (µg ai/L)	RQ	
		max.	avg		max.	avg
Inland Marina:						
Vascular spp.	9.3	0.409	0.269	4.0	0.1	<0.1
	6.5	0.286	0.188		<0.1	<0.1
Inland Small Marina:						
Vascular spp.	9.3	1.560	0.981	4.0	0.4	0.2
	6.5	1.090	0.686		0.3	0.2
Coastal Marina:						
Vascular spp.	9.3	0.418	0.276	4.0	0.1	<0.1
	6.5	0.286	0.188		<0.1	<0.1
Coastal Harbor:						
Vascular spp.	9.3	0.097	0.048	4.0	<0.1	<0.1
	6.5	0.068	0.033		<0.1	<0.1

Aquatic Risk Characterization

Based on the predicted exposure levels and the risk quotient methodology, RASSB presumes that the leaching of copper pyrithione from watercraft will pose an acute risk to listed (i. e., threatened and endangered) fish and aquatic invertebrates inhabiting inland (freshwater) marinas. Nonlisted fish also may be at risk in small inland marinas. In coastal (saltwater) settings, listed invertebrates are presumed at risk in marinas, but no acute LOC is exceeded for the harbor scenario. For both inland and coastal settings, minimal risks are presumed for nontarget aquatic plants, chronic exposure to fish and invertebrates, and exposure of invertebrates to contaminated sediment.

Because copper pyrithione is very highly toxic to most freshwater and saltwater organisms in the water column, potential risks largely depend on the extent of exposure to the leachate. Leaching data are available for two of the four proposed color formulations, but many uncertainties exist in the exposure assessment. For the screening assessment, RASSB is relying on the MAM-PEC European scenarios, with minor modifications (e.g., temperature, pH) for expected U. S. conditions. The MAM-PEC scenarios consider many measured variables for European settings,

including hydrological and environmental factors, compartment sizes (e.g., marinas, harbors), and watercraft sizes and numbers in marinas and harbors. For example, the default marina scenario in MAM-PEC is based on an actual French Mediterranean marina in the Golfe Juan (Van Hattum et al. 2002). The extent to which these European conditions approximate those of U. S. marinas and harbors is unknown and needs to be determined. The risk assessment could be refined if such information on U. S. coastal and inland marinas and harbors were available. Such relevant information would include environmental and hydrological conditions, typical dimensions (and range of dimensions) of freshwater and coastal marinas and harbors, number and sizes of watercraft, antifoulant usage, geographical variations in these factors, and others.

RASSB notes that the EECs in this assessment are based only on the in-service use of copper pyrithione leaching from watercraft hulls in the water. Emission to the environment also can occur at application of the antifoulant paint to the hull and at removal of paint from the hull (OECD 2005). The product label states that removed paint chips must be kept out of the water, it is likely that some will enter the aquatic environment in some situations. Such additional exposure may add to risk, but the extent of that exposure is uncertain at this time and is not addressed in the risk assessment.

It also should be strongly emphasized that copper oxide also will be leaching from the proposed end-use product, which consists of 3.96% copper pyrithione and 36.2% cuprous oxide. While RASSB only assesses risks from individual active ingredients, aquatic organisms will be exposed to both copper pyrithione and cuprous oxide leaching simultaneously from this antifoulant paint into the aquatic environment. Cuprous oxide also is highly toxic to aquatic organisms, and combined exposure to these two active ingredients will likely results in more severe acute and chronic affects than if the product consisted solely of copper pyrithione. A more refined risk assessment for the end-use product would consider the exposure and risk from the simultaneous exposure of aquatic organisms to both active ingredients.

Copper pyrithione, because it rapidly photodegrades into less toxic degradates, has been touted as posing considerably less risk to aquatic organisms than do some other current or formerly registered antifoulants (e.g., TBT). While photodegradation does occur rapidly in the presence of sunlight, photodegradation may be much less pronounced or minimal under conditions of low light attenuation, such as beneath watercraft, docks, and mooring structures or in the murky waters typical of many marinas. Bellas et al. (2005) examined the toxicity of zinc pyrithione to sea urchin (*Paracentrotus lividus*) and mussel (*Mytilus edulis*). Toxic effects on larval growth of sea urchin were detected at concentrations as low as 0.16 µg ai/L. The authors calculated RQs based on predicted environmental concentrations reported by Madsen et al. (2000 as cited in Bellas et al. 2005) in a pleasure-craft harbor in Europe. When photodegradation was ignored, RQs = 15 for mussels and 106 for urchins. However, even when photodegradation was considered, RQs = 4.9 for mussels and 35 for urchins. The authors conclude, based on their assertion that an RQ >1 presumes risk, that zinc pyrithione predicted concentrations in marinas pose a threat to mussel and urchin early stages regardless of whether photodegradation is a factor or not.

Terrestrial Risk Characterization

Birds and mammals are presumed to have little exposure to copper pyrithione from its use as an antifoulant coating on boat hulls. Possible routes of exposure include dermal uptake by swimming and wading birds in harbors and consumption of fish and invertebrates containing copper pyrithione residues. Based on the available data bridged from zinc pyrithione, RASSB assumes that copper pyrithione is not likely to bioconcentrate in aquatic organisms (bioconcentration factor <1 for zinc pyrithione). In addition, copper pyrithione is not highly toxic to birds or mammals and predicted water concentrations are exceedingly low (parts per trillion). Therefore, ingestion of prey items exposed to copper pyrithione is not likely to pose much risk to birds or wild mammals. Possible adverse affects from dermal exposure are unknown.

Endangered Species Considerations

Section 7 of the Endangered Species Act (ESA), 16 U.S.C. Section 1536(a)(2), requires that federal agencies consult with the National Marine Fisheries Service (NMFS) for marine and andronomus listed species, or with the United States Fish and Wildlife Services (FWS) for listed wildlife and freshwater organisms, if proposing an "action" that may affect listed species or their designated habitat. Each federal agency is required under the Act to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. To jeopardize the continued existence of a listed species is to "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species." 50 C.F.R. §402.02.

To comply with subsection (a)(2) of the ESA, EPA's Office of Pesticide Programs has established procedures to evaluate whether a proposed registration action may directly or indirectly appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of any listed species (U.S. EPA 2004). If any of the Listed Species LOC Criteria are exceeded for either direct or indirect effects in the Agency's screening-level risk assessment, the Agency identifies any listed or candidate species that may occur spatially and temporally in the footprint of the proposed use. Further biological assessment is undertaken to refine the risk. The extent to which any species may be at risk determines the need to develop a more comprehensive consultation package as required by the ESA.

The assessment for the proposed antifoulant paint use indicates that there is a potential for copper pyrithione exposure of listed freshwater and estuarine/marine organisms, and a more refined assessment is warranted for direct, indirect, and habitat effects. The refined assessment will involve clear delineation of the action area associated with proposed use of copper pyrithione and best available information on the temporal and spatial co-location of listed species with respect to the action area. A species-specific endangered species effect determination has not been conducted for this assessment but will be conducted during Registration Review.

References

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Maraldo, K. and L. Dahliof. 2004. Seasonal variations in the effect of zine pyrithione and copper pyrithione on pelagic phytoplankton communities. Aquatic toxicology (2004)): 189-198.

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Van Hattum, B., A.. Baart and J. Boon (2002). Computer model to generate predicted environmental concentrations (PECs) for antifouling products in the marine environment. Report number 2002/E-02-04 / Z 3117. Web-site: www.cepe.org; Publications; Antifouling products.

Appendix A: Data Requirements and Available Guideline Ecotoxicity Data for Copper Pyrithione

The toxicity endpoints used in OPP's assessments are obtained from guideline toxicity studies conducted for wildlife, aquatic organisms, and plants (40 CFR §158). Guideline studies are required to provide acute and reproductive/chronic measures of effect for one or more test species in several taxonomic groups. Some studies are only required on a case-by-case basis, depending on factors such as use patterns and environmental fate characteristics.

The new chemical screen for copper pyrithione, dated June 2, 2004, determined that a full ecotoxicity data set for copper pyrithione will not be required. The available data submitted (if deemed acceptable after review) were considered to be sufficiently similar to the existing data for zinc pyrithione to allow bridging between these two pyrithione compounds.

Terrestrial Animals

Birds, Acute and Dietary

The Agency requires one acute-oral study to establish the toxicity of copper pyrithione (technical grade active ingredient, TGAI) to birds. The preferred test species is either the mallard (*Anas platyrhynchos*) or the northern bobwhite (*Colinus virginianus*). Avian dietary toxicity studies (northern bobwhite and mallard) are conditionally required for antimicrobial pesticides used as antifoulant coatings and paint. The available acute-oral and dietary studies indicate that the pyrithiones are moderately to practically nontoxic to birds (Table 1A). The guidelines for avian acute-oral toxicity (OPPTS 850.2100) and avian dietary toxicity OPPTS 850.2200) are satisfied.

Table 1A. Acute-oral (LD50) and Dietary (LC50) Toxicity to Birds

Test Species	Test material (% ai)	Toxicity Endpoint (95% CI)	Toxicity Category	Study Status	MRID No.
Northern bobwhite	copper pyrithione (99.5)	LD50 = 126 mg ai/kg bw (84-194)	moderately toxic	core	457743-21
	Zinc pyrithione (96)	LD50 = 60 mg ai/kg bw (44-81)	moderately toxic	core	43864611
		LC50 = 1063 ppm ai (789-1412)	slightly toxic	core	438646-10
Mallard	Zinc pyrithione (96)	LC50 >5000 ppm ai	practically nontoxic	core	438646-12

Mammals, Acute

The available mammalian acute toxicity data indicate that the pyrithiones are slightly to moderately toxic to small mammals on an acute-oral basis (lab. rat LD50s = 630 mg ai/kg bw, males, and 460 mg ai/kg bw, females; MRID 428279-01). Refer to the human toxicology chapter for more details on these and other mammalian toxicity studies submitted in support of the human-health assessment.

Aquatic Organisms

Freshwater Fish, Acute

Studies are required with the TGAI to establish the acute toxicity of copper pyrithione to two species of freshwater fish. The preferred test species are the rainbow trout (*Oncorhynchus mykiss*), a coldwater fish, and the bluegill (*Lepomis macrochirus*), a sunfish. Both copper pyrithione and zinc pyrithione are very highly toxic to freshwater fish (Table 2A). The guideline for freshwater-fish acute toxicity (OPPTS 850.1075) is satisfied.

Table 2A. Acute Toxicity of Copper Pyrithione and Zinc Pyrithione to Freshwater Fish Exposed in the Water Column

Test Species	Test material (% ai)	96-h LC50 (µg ai/L) (95% CI)	Toxicity Category	Study Status	MRID No.
Rainbow trout	zinc pyrithione (97.8)	3.6 (3.0-4.3)	very highly toxic	core	438646-13
Fathead minnow	zinc pyrithione (97.8)	2.6 (2.1-3.2)	very highly toxic	core	438646-06
	copper pyrithione (94.7)	4.3 (3.7-5.0)	very highly toxic	core	457743-18

Freshwater Invertebrates, Acute

A study with the TGAI is required to establish the acute toxicity of copper pyrithione to freshwater invertebrates. The preferred test species is the water flea, *Daphnia magna*. Both copper pyrithione and zinc pyrithione are very highly toxic to fish (Table 3A). The guideline requirement (OPPTS 850.1010) is satisfied.

Table 3A. Acute Toxicity of Copper Pyrithione and Zinc pyrithione to Freshwater Invertebrates Exposed in the Water Column

Test Species	Test material (% ai)	48-h EC50 (µg ai/L) (95% CI)	Toxicity Category	Study Status	MRID No.
Waterflea	copper pyrithione (94.7)	10.1 (7.9-13)	very highly toxic	core	457743-16
	zinc pyrithione (97.8)	8.2 (5.2-25.8)	very highly toxic	core	438646-04

Estuarine/Marine Fish and Invertebrates, Acute

Acute toxicity data for the TGAI with estuarine/marine fish and two invertebrate species are required for antifoulant coatings and paints, because of their direct release via leaching into the estuarine/marine environment. The preferred fish test species is sheepshead minnow (*Cyprinodon variegatus*) and preferred invertebrate species are the mysid shrimp (*Mysidopsis bahia*) and Eastern oyster (*Crassostrea virginica*). The available data categorize copper pyrithione and zinc pyrithione as being highly toxic to saltwater fish and very highly toxic to saltwater invertebrates (Table 4A). The guideline requirements for estuarine/marine fish and invertebrate acute toxicity testing (OPPTS 850.1075, 850.1025, and 850.1035) are satisfied.

Table 4A. Acute Toxicity of Copper Pyrithione and Zinc Pyrithione to Estuarine/Marine Fish and Invertebrates Exposed in the Water Column

Test Species	Test material (% ai)	96-h LC50 (µg ai/L) (95% CI)	Toxicity Category	Study Status	MRID No.
Sheepshead minnow	zinc pyrithione (97.8)	400 (200-590)	highly toxic	core	438646-05
Mysid shrimp	zinc pyrithione (97.8)	4.7 (4.0-5.5)	very highly toxic	core	438646-07
Eastern oyster	copper pyrithione (94.7)	9.2 (0-∞)	very highly toxic	core	457743-17
	zinc pyrithione (97.8)	22.0 (18.9-27.3)	very highly toxic	core	438646-08

Degradates, Acute Toxicity to Fish and Aquatic Invertebrates

Some acute toxicity data are available for two of the pyrithione degradates (pyridine sulfonic acid and pyrithione sulfonic acid). The data are sufficient to categorize both degradates as being only slightly toxic to practically nontoxic to freshwater and saltwater fish and invertebrates (Table 5A).

Table 5A. Acute Toxicity of Two Pyrithione Degradates to Fish and Aquatic Invertebrates Exposed in the Water Column

Test Species	Test material (% ai)	96-h LC50 (µg ai/L) (95% CI)	Toxicity Category	Study Status	MRID No.
Rainbow trout	pyridine sulfonic acid (98)	57,100 (48,300-69,800)	slightly toxic	core	438646-27
	pyrithione sulfonic acid (98.5)	92,300 (73,600-124,000)	slightly toxic	core	438646-16
	pyridine sulfonic acid (98)	68,500 (55,200-85,000)	slightly toxic	core	438646-21
	pyrithione sulfonic acid (98.5)	58,800 (48,700-71,000)	slightly toxic	core	438646-18
Waterflea	pyridine sulfonic acid (98)	>122,000	practically nontoxic	core	438646-22
	pyrithione sulfonic acid (98.5)	>127,000	practically nontoxic	core	438646-19
Sheepshead minnow	pyridine sulfonic acid (98)	>127,000	practically nontoxic	core	438646-23
	pyrithione sulfonic acid (98.5)	>137,000	practically nontoxic	core	438646-17
Mysid shrimp	pyridine sulfonic acid (98)	71,000 (62,800-81,100)	slightly toxic	core	438646-26
	pyrithione sulfonic acid (98.5)	70,300 (61,600-81,600)	slightly toxic	core	438646-20
Eastern oyster	pyridine sulfonic acid (98)	85.600 (73,300-102,500)	slightly toxic	core	438646-24

	pyrithione sulfonic acid (98.5)	96,200 (89,313-104,560)	slightly toxic	core	438646-15

Aquatic Organisms, Chronic

Chronic testing of fish and aquatic invertebrates is required for copper pyrithione, because it is discharged via leaching directly into the aquatic environment. The preferred test species are the fish and invertebrate species most sensitive in the acute studies. The available data for the pyrithiones and degradates indicate that adverse affects on survival, growth, and reproduction occur at concentrations from about 1 to 10 µg ai/L (Table 6A). The guideline requirements (OPPTS 850.1400, 850.1300/1350) are satisfied.

Table 6A. Chronic Toxicity of Copper Pyrithione and Zinc Pyrithione and a Degradate to Freshwater Fish and Invertebrates Exposed in the Water Column

Test Species	% ai tested	NOEC/LOEC (µg ai/L)	Endpoints affected	Study Status	MRID No.
Fathead minnow	copper pyrithione (96.4)	0.98 / 1.9	survival, sublethal effects, length, weight	core	457743-18
	zinc pyrithione (98.2)	1.2 / 2.8	hatching, growth, sublethal effects	core	452041-02
	pyridine-2-sulfonic acid (98.2)	NOEC = 10	none at the highest concentration tested	core	452041-02
Waterflea	zinc pyrithione (98.2)	2.7 / 5.8	reproduction, growth	core	445354-01
Mysid shrimp	zinc pyrithione (98.2)	2.2 / 4.2 4.2 / 9.1	growth reproduction	core	449111-01

Aquatic Plants

Aquatic plant growth testing (TGAI or TEP) is required for copper pyrithione because of its discharge via leaching into the aquatic environment. Test species include duckweed (*Lemna gibba*), a vascular plant, and four non-vascular species: (1) freshwater green alga, *Selenastrum capricornutum,* (2) marine diatom, *Skeletonema costatum,* (3) freshwater diatom, *Navicula pelliculosa,* and (4) bluegreen cyanobacteria, *Anabaena flos-aquae.* The available aquatic plant data indicate that the marine diatom is the most sensitive species (Table 7A). The guideline

requirement for aquatic plant growth testing (OPPTS 850.5400) is satisfied.

Table 7A. Toxicity of Copper Pyrithione and Zinc Pyrithione to Aquatic Plants

Test Species	% ai tested	EC50 (µg ai/L)	NOEC (µg ai/L)	Study Status	MRID No.
Duckweed	zinc pyrithione (97.8)	8.8	4.0	core	452041-04
Freshwater green alga	zinc pyrithione (97.8)	28	7.8	core	438646-09
	copper pyrithione (94.7)	35	18	core	457743-19
Blue-green alga	zinc pyrithione (98.3)	7.1	3.8	core	455649-01
Marine diatom	zinc pyrithione (98.2)	0.65	0.46	core	462503-05
Freshwater diatom	zinc pyrithione (98.3)	2.6	2.4	core	455650-01

Freshwater green alga also were tested with two degradates. Both degradates are considerably less toxic to green alga than are copper pyrithione and zinc pyrithione (Table 8A). However, there are data in the literature demonstrating that two photodegradates (2-mercaptopyridine-N-oxide and 2.2'-dithio-bis-pyridin-N-oxide) are about as toxic (1.1-3.4 µg ai/L) to the marine diatom as are the parent pyrithiones (Onduka et al. 2007).

Table 8A. Toxicity of Two Pyrithione Degradates to Aquatic Plants

Test Species	% ai tested	EC50 (µg ai/L)	NOEC (µg ai/L)	Study Status	MRID No.
Freshwater green alga	pyridine sulfonic acid (98)	28,900	5460	core	438646-25
	pyrithione sulfonic acid (98.5)	28,200	11,800	core	438646-14

Terrestrial Plants

A seedling-emerge test with rice (*Oryza sativa*) is required for all pesticides having antifoulant paint and coating uses. Data were not submitted for copper pyrithione, but a study available for zinc pyrithione determined an EC25 (Table 9A). The guideline requirement (OPPTS 850.4225) is satisfied.

Table 9A. Seedling-emergence Toxicity of Zinc Pyrithione to Rice

Test Species	Test	% ai tested	EC25 (mg ai/kg)	NOEC (mg ai/kg)	Study Status	MRID No.
Rice	seedling emergence	zinc pyrithione (98.3)	172	100	core	462503-01

Sediment Toxicity

Acute, whole-sediment tests with freshwater and saltwater invertebrates are required for antifoulant paints and coatings. Two studies were conducted with zinc pyrithione (Table 10A). However, the study testing a marine amphipod did not establish an EC50, and thus is not adequate to calculate an RQ. The guideline requirement (OPPTS 850.1735) is satisfied. However, because an EC50 or LC50 was not determined for the marine amphipod, the guideline requirement (OPPTS 850.1740) is not satisfied for a whole-sediment acute toxicity test with a marine invertebrate.

Table 10A. Acute Sediment Toxicity of Zinc Pyrithione to Freshwater and Estuarine/Marine Invertebrates

Test Species	% ai	10-d EC50/LC50 (mg/kg dry sediment)	Study Status	MRID No.
Freshwater amphipod (*Hyalella azteca*)	zinc pyrithione (98.2)	2.1	core	462503-03
Marine amphipod (*Leptocheirus plumulosus*)	zinc pyrithione (98.2)	<1.08	supplemental	462503-04

Appendix B: Copper Pyrithione MAM-PEC Runs for U. S. Inland and Coastal Marinas and Harbors and Surrounding Waters

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

11/10/2008

MEMORANDUM

SUBJECT: **Estimated Environmental Concentrations (EECs) for Antifoulant use of Copper Pyrithion**

From: **Siroos Mostaghimi, Ph.D., Senior Scientist**
Risk Assessment and Science Support Branch (RASSB)
Antimicrobials Division (7510P)

To: **Norm Cook, Chief**
Risk Assessment and Science Support Branch (RASSB)
Antimicrobials Division (7510P)

Chemical NO: 088001

DP No.: 346521

Attached please find the Estimated Environmental Concentrations (EECs) for antifoulant use of Copper Pyrithion. The MAM-PEC (Version 2) model was used to estimate the concentrations of Copper Pyrithion TBTO in water and sediments from application of antifoulant paints applied on ships and other water recreational vehicles.

Background:

The Arch Chemicals, Inc. has submitted an application for registration for a manufacturing use product containing Copper Omadine (Copper pyrithion), for use only in formulating antifoulant paints. This report provides Estimated Environmental Concentrations (EECs) for the use of Copper pyrithion as an antifoulant.

MAM-PEC is used as an assessment tool for antifoulant risk assessments in Europe. MAM-PEC was developed by the Institute of Environmental Studies/IVM and Delft Hydraulics for the European Paint Makers Association (CEPE) for conducting risk assessments for antifouling agents. The model provides prediction of environmental concentrations of antifouling products in six generalized "typical" marine environments (commercial harbor, estuarine harbor, marina, marina poorly flushed, open sea, and shipping lane). The version 2 of MAMPEC was used for this report.

EECs are generated using MAMPEC for the highest leaching rates (9.3 µg/cm^2/day, dark red formulation; 6.5 µg/cm^2/day, brown formulation) for all scenarios.

Several MAMPEC scenarios were chosen for these runs which are briefly described below.

The estimated environmental concentrations (EECs) could be used for ecological risk assessment based on the availability of ecological toxicity data.

Summary of the Results:

Scenario 1- Inland Marina

Input

Environment : Default marina 1-Fresh water-InLand
Compound : Copper Omadine (default)
Emission : Default Marina 100% Cu- Omadine-Fresh Water-Inland
Load : 4.37E+02:g/d (LR=6.5 µg /cm^2/day and 6.26E+02:g/d (LR=9.3 µg /cm^2/day)

A summary of the results for MAMPEC model runs for Inland Marina for two leaching rates (9.3 µg /cm^2/day and 6.5 µg /cm^2/day) are presented in Table 1 and 2. Total and dissolved concentrations in water as well as concentrations of Copper Pyrithion in sediments after one year are shown. The detailed input and output of the MAMPEC model run are shown in Appendix A.

Table 1. Estimated Environmental Concentrations of Cu-Pyrithion in an inland marina--The leaching rate was 6.5 µg /cm^2/day

	Total concentration (µg /l)	Dissolved (µg /l	Suspended matter (µg /g dw)	Sediment after one year (µg /g) dw
Maximum concentration	2.86E-01	2.82E-01	8.07E-02	3.38E-07
95% confidence	2.76E-01	2.72E-01	7.77E-02	3.26E-07
Average concentration	1.88E-01	1.85E-01	5.30E-02	2.22E-07
Median concentration	1.86E-01	1.84E-01	5.25E-02	2.20E-07
Minimum concentration	3.96E-02	3.91E-02	1.12E-02	4.68E-08

Table 2. Estimated Environmental Concentrations of Cu-Pyrithion in an inland Marina The leaching rate was 9.3 µg /cm^2/day

	Total concentration (µg /l)	Dissolved (µg /l	Suspended matter (µg /g dw)	Sediment after one year (µg /g) dw
Maximum concentration	4.09E-01	4.04E-01	1.15E-01	4.84E-07
95% confidence	3.94E-01	3.89E-01	1.11E-01	4.67E-07
Average concentration	2.69E-01	2.65E-01	7.58E-02	3.18E-07
Median concentration	2.66E-01	2.63E-01	7.51E-02	3.15E-07
Minimum concentration	5.66E-02	5.59E-02	1.60E-02	6.70E-08

Scenario 2- Inland Small Marina

Environment : Default marina-Swiss marina 1
Compound : Copper Omadine (default)
Emission : Default Marina 100% Cu-Omadine-6.5
Load : 9.75E+01:g/d (LR=6.5 µg /cm^2/day) and 1.40E+02:g/d (LR=9.5 µg /cm^2/day)

A summary of the results for this MAMPEC model runs are presented in Table 3 and 4. Total and dissolved concentrations in water as well as concentrations of Copper Pyrithion in

sediment after one year are shown. The detailed input and output of the MAMPEC model run are shown in Appendix B.

Table 3 . Estimated Environmental Concentrations of Cu-Pyrithion in a Small Inland Marina-The leaching rate was 6.5 µg /cm^2/day

	Total concentration (µg /l)	Dissolved (µg /l)	Suspended matter (µg /g dw)	Sediment after one year (µg /g) dw
Maximum concentration	1.09E+00	1.07E+00	3.07E-01	1.29E-06
95% confidence	1.09E+00	1.07E+00	3.07E-01	1.29E-06
Average concentration	6.86E-01	6.77E-01	1.93E-01	8.12E-07
Median concentration	6.38E-01	6.30E-01	1.80E-01	7.55E-07
Minimum concentration	2.22E-01	2.19E-01	6.25E-02	2.62E-07

Table 4. Estimated Environmental Concentrations of Cu-Pyrithion, in a Small Inland Mrina. The leaching rate was 9.3 µg /cm^2/day

	Total concentration (µg /l)	Dissolved (µg /l	Suspended matter (µg /g dw)	Sediment after one year (µg /g) dw
Maximum concentration	1.56E+00	1.54E+00	4.39E-01	1.84E-06
95% confidence	1.56E+00	1.54E+00	4.39E-01	1.84E-06
Average concentration	9.81E-01	9.69E-01	2.77E-01	1.16E-06
Median concentration	9.12E-01	9.01E-01	2.57E-01	1.08E-06
Minimum concentration	3.17E-01	3.13E-01	8.95E-02	3.75E-07

Scenario 3- Coastal Marina

Environment : Default marina for salt water
Compound : Copper Omadine (default)
Emission : Default Marina 100% Cu-Omadine
Load : 4.37E+02:g/d (LR=6.5 µg /cm^2/day) and 6.26E+02:g/d (LR=9.3 µg /cm^2/day)

A summary of the results for this MAMPEC model runs are presented in Table 5 and 6.

Total and dissolved concentrations in water as well as concentrations of Copper Pyrithion in sediment after one year are shown. The detailed input and output of the MAMPEC model run are shown in Appendix C.

Table. 5. Estimated Environmental Concentrations of Cu-Pyrithion in a Coastal Marina. The Leaching rate used was 6.5 µg /cm^2/day.

	Total concentration (µg /l)	Dissolved (µg /L)	Suspended matter (µg /g dw)	Sediment after one year (µg /g) dw
Maximum concentration	2.86E-01	2.82E-01	8.07E-02	1.69E-06
95% confidence	2.76E-01	2.72E-01	7.77E-02	1.63E-06
Average concentration	1.88E-01	1.85E-01	5.30E-02	1.11E-06
Median concentration	1.86E-01	1.84E-01	5.25E-02	1.10E-06
Minimum concentration	3.96E-02	3.91E-02	1.12E-02	2.34E-07

Table 6. Estimated Environmental Concentrations of Cu-Pyrithion in a Coastal Marina. The leaching rate used was 9.3 µg /cm^2/day

	Total concentration (µg /l)	Dissolved (µg /L)	Suspended matter (µg /g dw)	Sediment after one year (µg /g) dw
Maximum concentration	4.18E-01	4.13E-01	1.18E-01	2.48E-06
95% confidence	4.03E-01	3.98E-01	1.14E-01	2.38E-06
Average concentration	2.76E-01	2.72E-01	7.78E-02	1.63E-06
Median concentration	2.74E-01	2.71E-01	7.74E-02	1.62E-06
Minimum concentration	5.83E-02	5.76E-02	1.64E-02	3.45E-07

Scenario 4- Coastal Harbor

Environment : Default estuarine harbor 1
Compound : Copper Omadine (default)
Emission : Default Estuarine Harbour-1
Load : 6.29E+03:g/d (LR=6.5 µg /cm^2/day) and 8.99E+03:g/d (LR=9.3 µg /cm^2/day)

A summary of the results for this MAMPEC model runs are presented in Table 7 and 8. Total and dissolved concentrations in water as well as concentrations of Copper Pyrithion in

sediment after one year are shown. The detailed input and output of the MAMPEC model run are shown in Appendix D.

Table. 7. Estimated Environmental Concentrations of Cu-Pyrithion in a Costal Harbor. The Leaching rate used was 6.5 µg /cm^2/day.

	Total concentration (µg /l)	Dissolved (µg /L)	Suspended matter (µg /g dw)	Sediment after one year (µg /g) dw
Maximum concentration	6.76E-02	6.68E-02	1.91E-02	4.00E-07
95% confidence	6.24E-02	6.16E-02	1.76E-02	3.69E-07
Average concentration	3.34E-02	3.30E-02	9.42E-03	1.98E-07
Median concentration	2.56E-02	2.53E-02	7.23E-03	1.52E-07
Minimum concentration	4.95E-03	4.89E-03	1.40E-03	2.93E-08

Table 8. Estimated Environmental Concentrations of Cu-Pyrithion in a Costal Harbor. The leaching rate used was 9.3 µg /cm^2/day

	Total concentration (µg /l)	Dissolved (µg /L)	Suspended matter (µg /g dw)	Sediment after one year (µg /g) dw
Maximum concentration	9.68E-02	9.55E-02	2.73E-02	5.72E-07
95% confidence	8.93E-02	8.81E-02	2.52E-02	5.28E-07
Average concentration	4.78E-02	4.72E-02	1.35E-02	2.83E-07
Median concentration	3.67E-02	3.62E-02	1.03E-02	2.17E-07
Minimum concentration	7.09E-03	7.00E-03	2.00E-03	4.19E-08

These EECs from these scenarios could be used for ecological risk assessment of both fresh and salt water.

References:

Baart, T, Boon, J, and B. Van Hattum. 2008. User Manual-Quick Guide. MAM-PEC Version 2. European Commission, CEPEWL, IRM.

USEPA. 2007. Review of the Leach rate data for interswift 655 BMA008 brown containing cuprous oxide (36.2%) and copper pyrithion (3.96%) antifoulant agent. Sriniwas Gowda to Marshall Swindle. June 12, 2007

File: C:\Myfiles\2008 Reports\Cu-Pyrithion/ Estimated Environmental Concentrations (EECs) for Copper Pyrithion

CC: RASSB Chemical File

Siroos Mostaghimi /RASSB

Appendix A

Inputs, parameters and out put results from the MAMPEC Model run for Scenario 1

MAMPEC - Result Sheet-Leaching Rate=6.5 µg /cm^2/day

Run : Default marina-Swiss marina 1 Copper Omadine (default) Default Marina 100% Cu-Omadine-9.3
Version : MamPec 2.0
Run date : 11/4/2008 2:05:47 PM
Memo :

Input
Environment : Default marina 1-Fresh water-InLand
Compound : Copper Omadine (default)
Emission : Default Marina 100% Cu-Omadine-Fresh Water-Inland
Load : 4.37E+02:g/d

Results

Total concentration in water

Maximum concentration	: 2.86E-01	:ug/l
95 % concentration	: 2.76E-01	:ug/l
Average concentration	: 1.88E-01	:ug/l
Median concentration	: 1.86E-01	:ug/l
Minimum concentration	: 3.96E-02	:ug/l

Dissolved concentration in water

Maximum concentration	: 2.82E-01	:ug/l
95 % concentration	: 2.72E-01	:ug/l
Average concentration	: 1.85E-01	:ug/l
Median concentration	: 1.84E-01	:ug/l
Minimum concentration	: 3.91E-02	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 8.07E-02	:ug/g dw
95 % concentration	: 7.77E-02	:ug/g dw
Average concentration	: 5.30E-02	:ug/g dw
Median concentration	: 5.25E-02	:ug/g dw
Minimum concentration	: 1.12E-02	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 3.38E-07	:ug/g dw
95 % concentration	: 3.26E-07	:ug/g dw
Average concentration	: 2.22E-07	:ug/g dw
Median concentration	: 2.20E-07	:ug/g dw
Minimum concentration	: 4.68E-08	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 3.38E-07	:ug/g dw
95 % concentration	: 3.26E-07	:ug/g dw
Average concentration	: 2.22E-07	:ug/g dw

Median concentration	: 2.20E-07	:ug/g dw
Minimum concentration	: 4.68E-08	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 3.38E-07	:ug/g dw
95 % concentration	: 3.26E-07	:ug/g dw
Average concentration	: 2.22E-07	:ug/g dw
Median concentration	: 2.20E-07	:ug/g dw
Minimum concentration	: 4.68E-08	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 3.38E-07	:ug/g dw
95 % concentration	: 3.26E-07	:ug/g dw
Average concentration	: 2.22E-07	:ug/g dw
Median concentration	: 2.20E-07	:ug/g dw
Minimum concentration	: 4.68E-08	:ug/g dw

Results in surrounding waters

Total concentration in water

Maximum concentration	: 1.67E-02	:ug/l
95 % concentration	: 1.47E-02	:ug/l
Average concentration	: 9.15E-04	:ug/l
Median concentration	: 7.59E-03	:ug/l
Minimum concentration	: 6.45E-03	:ug/l

Dissolved concentration in water

Maximum concentration	: 1.65E-02	:ug/l
95 % concentration	: 1.45E-02	:ug/l
Average concentration	: 9.03E-04	:ug/l
Median concentration	: 7.49E-03	:ug/l
Minimum concentration	: 6.37E-03	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 4.70E-03	:ug/g dw
95 % concentration	: 4.14E-03	:ug/g dw
Average concentration	: 2.58E-04	:ug/g dw
Median concentration	: 2.14E-03	:ug/g dw
Minimum concentration	: 1.82E-03	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 1.97E-08	:ug/g dw
95 % concentration	: 1.74E-08	:ug/g dw
Average concentration	: 1.08E-09	:ug/g dw
Median concentration	: 8.98E-09	:ug/g dw
Minimum concentration	: 7.63E-09	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 1.97E-08	:ug/g dw
95 % concentration	: 1.74E-08	:ug/g dw
Average concentration	: 1.08E-09	:ug/g dw
Median concentration	: 8.98E-09	:ug/g dw
Minimum concentration	: 7.63E-09	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 1.97E-08	:ug/g dw
95 % concentration	: 1.74E-08	:ug/g dw
Average concentration	: 1.08E-09	:ug/g dw
Median concentration	: 8.98E-09	:ug/g dw
Minimum concentration	: 7.63E-09	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 1.97E-08	:ug/g dw
95 % concentration	: 1.74E-08	:ug/g dw
Average concentration	: 1.08E-09	:ug/g dw
Median concentration	: 8.98E-09	:ug/g dw
Minimum concentration	: 7.63E-09	:ug/g dw

MAMPEC - Input data sheet

Compound

Name	:	Copper-pyrithione	
Description	:	Copper Omadine (default)	
Molecular mass	:	315.85	:g/Mol
Vapor pressure	:	5.00E-07	:Pa
Solubility	:	6.00E-02	:g/m3
Octanol-water coefficient	:	2.44E+00	:(-) Log (Kow)
Kd	:	0.00E+00	:m3/kg
Koc	:	4.00E+00	:(-) Log(Koc), Koc expressed as l/kg OrganicCarbon
Henry's coefficient	:	2.60E-03	:Pa.m3/mol
Melting temperature	:	0.0	:oC
pKa	:	0.0	:(-)
in water			
Biological degradation rate	:	1.76E-01	:1/d
Hydrolytic degradation rate	:	3.82E-02	:1/d
Photolytic degradation rate	:	9.20E-01	:1/d
in sediment			
Biological degradation rate	:	6.30E-01	:1/d
Hydrolytic degradation rate	:	8.13E+00	:1/d
Photolytic degradation rate	:	0.00E+00	:1/d
Advanced Photodegradation calculation	:	False	
Reference	:		

Environment

Description	: Default marina 1-Fresh water-InLand	
Silt concentration	: 35.0	:g/m3
Particular organic carbon conc	: 1.0	:g Organic Carbon/m3
Dissolved organic carbon conc	: 2.0	:g/m3
Temperature	: 25.0	:oC
Salinity	: 5.00E+00	:s.e.
Depth well-mixed sediment top layer	: 1.00E-01	: m
Sediment density	: 1.000E+03	:kg/m3
Fraction organic carbon in sediment	: 3.00E-02	:-/-
Nett sedimentation velocity	: 1.00E-01	:m/d
pH	: 6.5	:(-)
Chlorophyll	: 3.00	:ug/l
Latitude	: 50.00 degrees NH	
Background concentrations	: 0.00E+00	:ug/l
Average windspeed	: 0.00	:m/s
Fraction wind perpendicular to harbour	: 0.00	:-/-
Daily maximum non tidal water level change	: 0.00	:m
Length of river, not part of harbor (x1)	: 400	:m
Width of harbor (y1)	: 400	:m
Length of harbor (x2)	: 400	:m
Width of river (y2)	: 400	:m
Depth of harbor	: 3.5	:m
Length of open harbour mouth (x3)	: 100	:m
Flow	: 1	:m/s
Flow of flushing into harbor	: 0	:m3/s
Tidal height	: 1	:m
Density difference	: 0.1	:kg/m3
Density difference flushing	: 0	:kg/m3
Tidal period	: 12.41	:h
Exchange surface	: 350	:m2
Depth at harbour mouth	: 3.5	:m
Height underwater dam at mouth	: 0	:m
Width underwater dam at mouth	: 0	:m
Length selected area	: 0	:m
Width selected area	: 0	:m
Depth selected area	: 0	:m
Flow	: 0	:m/s
Exchange volume in 1 tidal period	: 243420	:m3
Reference	:	

Emission

Description	: Default Marina 100% Cu-Omadine-Fresh Water-Inland	
Load	: 437.2875	:g/d
Loading due to moving ships	: 0	:g/d
Loading due to ships at berth	: 437.2875	:g/d
Leaching rate ships at berth	: 6.5	:ug/cm2/d
Leaching rate ships at berth	: 6.5	:ug/cm2/d
Number of ships at berth (Class 1)	: 0	
Number of ships at berth (Class 2)	: 299	
Number of ships at berth (Class 3)	: 0	
Number of ships at berth (Class 4)	: 0	
Number of ships at berth (Class 5)	: 0	
Number of ships at berth (Class 6)	: 0	

Number of ships at berth (Class 7)	: 0	
Number of ships at berth (Class 8)	: 0	
Number of ships at berth (Class 9	: 0	
Number of ships at berth (Class 10)	: 0	
Number of moving ships (Class 1)	: 0	
Number of moving ships (Class 2)	: 0	
Number of moving ships (Class 3)	: 0	
Number of moving ships (Class 4)	: 0	
Number of moving ships (Class 5)	: 0	
Number of moving ships (Class 6)	: 0	
Number of moving ships (Class 7)	: 0	
Number of moving ships (Class 8)	: 0	
Number of moving ships (Class 9)	: 0	
Number of moving ships (Class 10)	: 0	
Application factor (Class 1)	: 100	:%
Application factor (Class 2)	: 100	:%
Application factor (Class 3)	: 100	:%
Application factor (Class 4)	: 100	:%
Application factor (Class 5)	: 100	:%
Application factor (Class 6)	: 20	:%
Application factor (Class 7)	: 20	:%
Application factor (Class 8)	: 20	:%
Application factor (Class 9)	: 20	:%
Application factor (Class 10)	: 20	:%
Underwater ship area (Class 1)	: 20	:m2
Underwater ship area (Class 2)	: 22.5	:m2
Underwater ship area (Class 3)	: 450	:m2
Underwater ship area (Class 4)	: 3061	:m2
Underwater ship area (Class 5)	: 5999	:m2
Underwater ship area (Class 6)	: 9917	:m2
Underwater ship area (Class 7)	: 14814	:m2
Underwater ship area (Class 8)	: 22645	:m2
Underwater ship area (Class 9)	: 27547	:m2
Underwater ship area (Class 10)	: 39668	:m2
Ship Length (Class 1)	: 0-10	:m
Ship Length (Class 2)	: 10-50	:m
Ship Length (Class 3)	: 50-100	:m
Ship Length (Class 4)	: 100-150	:m
Ship Length (Class 5)	: 150-200	:m
Ship Length (Class 6)	: 200-250	:m
Ship Length (Class 7)	: 250-300	:m
Ship Length (Class 8)	: 300-350	:m
Ship Length (Class 9)	: 350-400	:m
Ship Length (Class 10)	: > 400	:m
Reference	: all assumptions are like the inland maris scenario except LR=6.5	

MAMPEC - Result Sheet-Leaching Rate 9.3 µg /cm^2/day

Run : Default marina-Swiss marina 1 Copper Omadine (default) Default Marina 100% Cu-Omadine-9.3
Version : MamPec 2.0
Run date : 11/4/2008 2:09:38 PM
Memo :

Input
Environment : Default marina 1-Fresh water-InLand
Compound : Copper Omadine (default)
Emission : Default Marina 100% Cu-Omadine-Fresh Water9.3
Load : 6.26E+02:g/d

Results

Total concentration in water

Maximum concentration	: 4.09E-01	:ug/l
95 % concentration	: 3.94E-01	:ug/l
Average concentration	: 2.69E-01	:ug/l
Median concentration	: 2.66E-01	:ug/l
Minimum concentration	: 5.66E-02	:ug/l

Dissolved concentration in water

Maximum concentration	: 4.04E-01	:ug/l
95 % concentration	: 3.89E-01	:ug/l
Average concentration	: 2.65E-01	:ug/l
Median concentration	: 2.63E-01	:ug/l
Minimum concentration	: 5.59E-02	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 1.15E-01	:ug/g dw
95 % concentration	: 1.11E-01	:ug/g dw
Average concentration	: 7.58E-02	:ug/g dw
Median concentration	: 7.51E-02	:ug/g dw
Minimum concentration	: 1.60E-02	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 4.84E-07	:ug/g dw
95 % concentration	: 4.67E-07	:ug/g dw
Average concentration	: 3.18E-07	:ug/g dw
Median concentration	: 3.15E-07	:ug/g dw
Minimum concentration	: 6.70E-08	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 4.84E-07	:ug/g dw
95 % concentration	: 4.67E-07	:ug/g dw
Average concentration	: 3.18E-07	:ug/g dw
Median concentration	: 3.15E-07	:ug/g dw
Minimum concentration	: 6.70E-08	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 4.84E-07	:ug/g dw
95 % concentration	: 4.67E-07	:ug/g dw
Average concentration	: 3.18E-07	:ug/g dw
Median concentration	: 3.15E-07	:ug/g dw
Minimum concentration	: 6.70E-08	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 4.84E-07	:ug/g dw
95 % concentration	: 4.67E-07	:ug/g dw
Average concentration	: 3.18E-07	:ug/g dw
Median concentration	: 3.15E-07	:ug/g dw
Minimum concentration	: 6.70E-08	:ug/g dw

Results in surrounding waters

Total concentration in water

Maximum concentration	: 2.39E-02	:ug/l
95 % concentration	: 2.10E-02	:ug/l
Average concentration	: 1.31E-03	:ug/l
Median concentration	: 1.09E-02	:ug/l
Minimum concentration	: 9.23E-03	:ug/l

Dissolved concentration in water

Maximum concentration	: 2.36E-02	:ug/l
95 % concentration	: 2.07E-02	:ug/l
Average concentration	: 1.29E-03	:ug/l
Median concentration	: 1.07E-02	:ug/l
Minimum concentration	: 9.11E-03	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 6.73E-03	:ug/g dw
95 % concentration	: 5.92E-03	:ug/g dw
Average concentration	: 3.69E-04	:ug/g dw
Median concentration	: 3.06E-03	:ug/g dw
Minimum concentration	: 2.60E-03	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 2.82E-08	:ug/g dw
95 % concentration	: 2.48E-08	:ug/g dw
Average concentration	: 1.55E-09	:ug/g dw
Median concentration	: 1.28E-08	:ug/g dw

Minimum concentration	: 1.09E-08	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 2.82E-08	:ug/g dw
95 % concentration	: 2.48E-08	:ug/g dw
Average concentration	: 1.55E-09	:ug/g dw
Median concentration	: 1.28E-08	:ug/g dw
Minimum concentration	: 1.09E-08	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 2.82E-08	:ug/g dw
95 % concentration	: 2.48E-08	:ug/g dw
Average concentration	: 1.55E-09	:ug/g dw
Median concentration	: 1.28E-08	:ug/g dw
Minimum concentration	: 1.09E-08	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 2.82E-08	:ug/g dw
95 % concentration	: 2.48E-08	:ug/g dw
Average concentration	: 1.55E-09	:ug/g dw
Median concentration	: 1.28E-08	:ug/g dw
Minimum concentration	: 1.09E-08	:ug/g dw

MAMPEC - Input data sheet

Compound

Name	:	Copper-pyrithione	
Description	:	Copper Omadine (default)	
Molecular mass	:	315.85	:g/Mol
Vapor pressure	:	5.00E-07	:Pa
Solubility	:	6.00E-02	:g/m3
Octanol-water coefficient	:	2.44E+00	:(-) Log (Kow)
Kd	:	0.00E+00	:m3/kg
Koc	:	4.00E+00	:(-) Log(Koc), Koc expressed as l/kg OrganicCarbon
Henry's coefficient	:	2.60E-03	:Pa.m3/mol
Melting temperature	:	0.0	:oC
pKa	:	0.0	:(-)
in water			
Biological degradation rate	:	1.76E-01	:1/d
Hydrolytic degradation rate	:	3.82E-02	:1/d
Photolytic degradation rate	:	9.20E-01	:1/d
in sediment			
Biological degradation rate	:	6.30E-01	:1/d
Hydrolytic degradation rate	:	8.13E+00	:1/d
Photolytic degradation rate	:	0.00E+00	:1/d
Advanced Photodegradation calculation	:	False	
Reference	:		

Environment

Description	: Default marina 1-Fresh water-InLand	
Silt concentration	: 35.0	:g/m3
Particular organic carbon conc	: 1.0	:g Organic Carbon/m3
Dissolved organic carbon conc	: 2.0	:g/m3
Temperature	: 25.0	:oC
Salinity	: 5.00E+00	:s.e.
Depth well-mixed sediment top layer	: 1.00E-01	: m
Sediment density	: 1.000E+03	:kg/m3
Fraction organic carbon in sediment	: 3.00E-02	:-/-
Nett sedimentation velocity	: 1.00E-01	:m/d
pH	: 6.5	:(-)
Chlorophyll	: 3.00	:ug/l
Latitude	: 50.00 degrees NH	
Background concentrations	: 0.00E+00	:ug/l
Average windspeed	: 0.00	:m/s
Fraction wind perpendicular to harbour	: 0.00	:-/-
Daily maximum non tidal water level change	: 0.00	:m
Length of river, not part of harbor (x1)	: 400	:m
Width of harbor (y1)	: 400	:m
Length of harbor (x2)	: 400	:m
Width of river (y2)	: 400	:m
Depth of harbor	: 3.5	:m
Length of open harbour mouth (x3)	: 100	:m
Flow	: 1	:m/s
Flow of flushing into harbor	: 0	:m3/s
Tidal height	: 1	:m
Density difference	: 0.1	:kg/m3
Density difference flushing	: 0	:kg/m3
Tidal period	: 12.41	:h
Exchange surface	: 350	:m2
Depth at harbour mouth	: 3.5	:m
Height underwater dam at mouth	: 0	:m
Width underwater dam at mouth	: 0	:m
Length selected area	: 0	:m
Width selected area	: 0	:m
Depth selected area	: 0	:m
Flow	: 0	:m/s
Exchange volume in 1 tidal period	: 243420	:m3
Reference	:	

Emission

Description	: Default Marina 100% Cu-Omadine-Fresh Water9.3	
Load	: 625.6575	:g/d
Loading due to moving ships	: 0	:g/d
Loading due to ships at berth	: 625.6575	:g/d
Leaching rate ships at berth	: 9.3	:ug/cm2/d
Leaching rate ships at berth	: 9.3	:ug/cm2/d
Number of ships at berth (Class 1)	: 0	
Number of ships at berth (Class 2)	: 299	
Number of ships at berth (Class 3)	: 0	
Number of ships at berth (Class 4)	: 0	
Number of ships at berth (Class 5)	: 0	
Number of ships at berth (Class 6)	: 0	
Number of ships at berth (Class 7)	: 0	

Number of ships at berth (Class 8)	: 0	
Number of ships at berth (Class 9	: 0	
Number of ships at berth (Class 10)	: 0	
Number of moving ships (Class 1)	: 0	
Number of moving ships (Class 2)	: 0	
Number of moving ships (Class 3)	: 0	
Number of moving ships (Class 4)	: 0	
Number of moving ships (Class 5)	: 0	
Number of moving ships (Class 6)	: 0	
Number of moving ships (Class 7)	: 0	
Number of moving ships (Class 8)	: 0	
Number of moving ships (Class 9)	: 0	
Number of moving ships (Class 10)	: 0	
Application factor (Class 1)	: 100	:%
Application factor (Class 2)	: 100	:%
Application factor (Class 3)	: 100	:%
Application factor (Class 4)	: 100	:%
Application factor (Class 5)	: 100	:%
Application factor (Class 6)	: 20	:%
Application factor (Class 7)	: 20	:%
Application factor (Class 8)	: 20	:%
Application factor (Class 9)	: 20	:%
Application factor (Class 10)	: 20	:%
Underwater ship area (Class 1)	: 20	:m2
Underwater ship area (Class 2)	: 22.5	:m2
Underwater ship area (Class 3)	: 450	:m2
Underwater ship area (Class 4)	: 3061	:m2
Underwater ship area (Class 5)	: 5999	:m2
Underwater ship area (Class 6)	: 9917	:m2
Underwater ship area (Class 7)	: 14814	:m2
Underwater ship area (Class 8)	: 22645	:m2
Underwater ship area (Class 9)	: 27547	:m2
Underwater ship area (Class 10)	: 39668	:m2
Ship Length (Class 1)	: 0-10	:m
Ship Length (Class 2)	: 10-50	:m
Ship Length (Class 3)	: 50-100	:m
Ship Length (Class 4)	: 100-150	:m
Ship Length (Class 5)	: 150-200	:m
Ship Length (Class 6)	: 200-250	:m
Ship Length (Class 7)	: 250-300	:m
Ship Length (Class 8)	: 300-350	:m
Ship Length (Class 9)	: 350-400	:m
Ship Length (Class 10)	: > 400	:m
Reference	: all assumptions are like the inland maris scenario except LR=9.3	

Appendix B

Inputs, parameters and out put results from the MAMPEC Model run for Scenario 2

MAMPEC - Result Sheet-Small Marina –LR=6.5 µg /cm^2/day

Run : Default marina-Swiss marina 1 Copper Omadine (default) Default Marina 100% Cu-Omadine-6.5
Version : MamPec 2.0
Run date : 11/4/2008 1:55:12 PM
Memo :

Input
Environment : Default marina-Swiss marina 1
Compound : Copper Omadine (default)
Emission : Default Marina 100% Cu-Omadine-6.5
Load : 9.75E+01:g/d

Results

Total concentration in water

Maximum concentration	: 1.09E+00	:ug/l
95 % concentration	: 1.09E+00	:ug/l
Average concentration	: 6.86E-01	:ug/l
Median concentration	: 6.38E-01	:ug/l
Minimum concentration	: 2.22E-01	:ug/l

Dissolved concentration in water

Maximum concentration	: 1.07E+00	:ug/l
95 % concentration	: 1.07E+00	:ug/l
Average concentration	: 6.77E-01	:ug/l
Median concentration	: 6.30E-01	:ug/l
Minimum concentration	: 2.19E-01	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 3.07E-01	:ug/g dw
95 % concentration	: 3.07E-01	:ug/g dw
Average concentration	: 1.93E-01	:ug/g dw
Median concentration	: 1.80E-01	:ug/g dw
Minimum concentration	: 6.25E-02	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 1.29E-06	:ug/g dw
95 % concentration	: 1.29E-06	:ug/g dw
Average concentration	: 8.12E-07	:ug/g dw
Median concentration	: 7.55E-07	:ug/g dw
Minimum concentration	: 2.62E-07	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 1.29E-06	:ug/g dw
95 % concentration	: 1.29E-06	:ug/g dw
Average concentration	: 8.12E-07	:ug/g dw
Median concentration	: 7.55E-07	:ug/g dw
Minimum concentration	: 2.62E-07	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 1.29E-06	:ug/g dw
95 % concentration	: 1.29E-06	:ug/g dw
Average concentration	: 8.12E-07	:ug/g dw
Median concentration	: 7.55E-07	:ug/g dw
Minimum concentration	: 2.62E-07	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 1.29E-06	:ug/g dw
95 % concentration	: 1.29E-06	:ug/g dw
Average concentration	: 8.12E-07	:ug/g dw
Median concentration	: 7.55E-07	:ug/g dw
Minimum concentration	: 2.62E-07	:ug/g dw

Results in surrounding waters

Total concentration in water

Maximum concentration	: 4.30E-02	:ug/l
95 % concentration	: 4.22E-02	:ug/l
Average concentration	: 4.08E-03	:ug/l
Median concentration	: 2.54E-02	:ug/l
Minimum concentration	: 1.86E-02	:ug/l

Dissolved concentration in water

Maximum concentration	: 4.28E-02	:ug/l
95 % concentration	: 4.17E-02	:ug/l
Average concentration	: 4.03E-03	:ug/l
Median concentration	: 2.50E-02	:ug/l
Minimum concentration	: 1.84E-02	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 1.22E-02	:ug/g dw
95 % concentration	: 1.19E-02	:ug/g dw
Average concentration	: 1.15E-03	:ug/g dw
Median concentration	: 7.15E-03	:ug/g dw
Minimum concentration	: 5.25E-03	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 5.13E-08	:ug/g dw
95 % concentration	: 4.99E-08	:ug/g dw
Average concentration	: 4.83E-09	:ug/g dw
Median concentration	: 3.00E-08	:ug/g dw
Minimum concentration	: 2.20E-08	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 5.13E-08	:ug/g dw
95 % concentration	: 4.99E-08	:ug/g dw
Average concentration	: 4.83E-09	:ug/g dw
Median concentration	: 3.00E-08	:ug/g dw
Minimum concentration	: 2.20E-08	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 5.13E-08	:ug/g dw
95 % concentration	: 4.99E-08	:ug/g dw
Average concentration	: 4.83E-09	:ug/g dw
Median concentration	: 3.00E-08	:ug/g dw
Minimum concentration	: 2.20E-08	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 5.13E-08	:ug/g dw
95 % concentration	: 4.99E-08	:ug/g dw
Average concentration	: 4.83E-09	:ug/g dw
Median concentration	: 3.00E-08	:ug/g dw
Minimum concentration	: 2.20E-08	:ug/g dw

MAMPEC - Input data sheet

Compound

Name	:	Copper-pyrithione	
Description	:	Copper Omadine (default)	
Molecular mass	:	315.85	:g/Mol
Vapor pressure	:	5.00E-07	:Pa
Solubility	:	6.00E-02	:g/m3
Octanol-water coefficient	:	2.44E+00	:(-) Log (Kow)
Kd	:	0.00E+00	:m3/kg
Koc	:	4.00E+00	:(-) Log(Koc), Koc expressed as l/kg OrganicCarbon
Henry's coefficient	:	2.60E-03	:Pa.m3/mol
Melting temperature	:	0.0	:oC
pKa	:	0.0	:(-)
in water			
Biological degradation rate	:	1.76E-01	:1/d
Hydrolytic degradation rate	:	3.82E-02	:1/d
Photolytic degradation rate	:	9.20E-01	:1/d
in sediment			
Biological degradation rate	:	6.30E-01	:1/d
Hydrolytic degradation rate	:	8.13E+00	:1/d
Photolytic degradation rate	:	0.00E+00	:1/d
Advanced Photodegradation calculation	:	False	
Reference	:		

Environment

Description	: Default marina-Swiss marina 1	
Silt concentration	: 35.0	:g/m3
Particular organic carbon conc	: 1.0	:g Organic Carbon/m3
Dissolved organic carbon conc	: 2.0	:g/m3
Temperature	: 25.0	:oC
Salinity	: 5.00E+00	:s.e.
Depth well-mixed sediment top layer	: 1.00E-01	: m
Sediment density	: 1.000E+03	:kg/m3
Fraction organic carbon in sediment	: 3.00E-02	:-/-
Nett sedimentation velocity	: 1.00E-01	:m/d

pH	: 6.5	:(-)
Chlorophyll	: 3.00	:ug/l
Latitude	: 50.00 degrees NH	
Background concentrations	: 0.00E+00	:ug/l
Average windspeed	: 0.00	:m/s
Fraction wind perpendicular to harbour	: 0.00	:-/-
Daily maximum non tidal water level change	: 0.00	:m
Length of river, not part of harbor (x1)	: 100	:m
Width of harbor (y1)	: 100	:m
Length of harbor (x2)	: 100	:m
Width of river (y2)	: 100	:m
Depth of harbor	: 2	:m
Length of open harbour mouth (x3)	: 30	:m
Flow	: 0.1	:m/s
Flow of flushing into harbor	: 0	:m3/s
Tidal height	: 1	:m
Density difference	: 0.1	:kg/m3
Density difference flushing	: 0	:kg/m3
Tidal period	: 12.41	:h
Exchange surface	: 60	:m2
Depth at harbour mouth	: 2	:m
Height underwater dam at mouth	: 0	:m
Width underwater dam at mouth	: 0	:m
Length selected area	: 0	:m
Width selected area	: 0	:m
Depth selected area	: 0	:m
Flow	: 0	:m/s
Exchange volume in 1 tidal period	: 15383 :m3	
Reference	: This is a Swiss Marina scenario taken from OECD 2005 report	

Emission

Description	: Default Marina 100% Cu-Omadine-6.5	
Load	: 97.5	:g/d
Loading due to moving ships	: 0	:g/d
Loading due to ships at berth	: 97.5 :g/d	
Leaching rate ships at berth	: 6.5	:ug/cm2/d
Leaching rate ships at berth	: 6.5	:ug/cm2/d
Number of ships at berth (Class 1)	: 75	
Number of ships at berth (Class 2)	: 0	
Number of ships at berth (Class 3)	: 0	
Number of ships at berth (Class 4)	: 0	
Number of ships at berth (Class 5)	: 0	
Number of ships at berth (Class 6)	: 0	
Number of ships at berth (Class 7)	: 0	
Number of ships at berth (Class 8)	: 0	
Number of ships at berth (Class 9	: 0	
Number of ships at berth (Class 10)	: 0	
Number of moving ships (Class 1)	: 0	
Number of moving ships (Class 2)	: 0	
Number of moving ships (Class 3)	: 0	
Number of moving ships (Class 4)	: 0	
Number of moving ships (Class 5)	: 0	
Number of moving ships (Class 6)	: 0	
Number of moving ships (Class 7)	: 0	

Number of moving ships (Class 8)	: 0	
Number of moving ships (Class 9)	: 0	
Number of moving ships (Class 10)	: 0	
Application factor (Class 1)	: 100	:%
Application factor (Class 2)	: 100	:%
Application factor (Class 3)	: 100	:%
Application factor (Class 4)	: 100	:%
Application factor (Class 5)	: 100	:%
Application factor (Class 6)	: 20	:%
Application factor (Class 7)	: 20	:%
Application factor (Class 8)	: 20	:%
Application factor (Class 9)	: 20	:%
Application factor (Class 10)	: 20	:%
Underwater ship area (Class 1)	: 20	:m2
Underwater ship area (Class 2)	: 22.5	:m2
Underwater ship area (Class 3)	: 450	:m2
Underwater ship area (Class 4)	: 3061	:m2
Underwater ship area (Class 5)	: 5999	:m2
Underwater ship area (Class 6)	: 9917	:m2
Underwater ship area (Class 7)	: 14814	:m2
Underwater ship area (Class 8)	: 22645	:m2
Underwater ship area (Class 9)	: 27547	:m2
Underwater ship area (Class 10)	: 39668	:m2
Ship Length (Class 1)	: 0-10	:m
Ship Length (Class 2)	: 10-50	:m
Ship Length (Class 3)	: 50-100	:m
Ship Length (Class 4)	: 100-150	:m
Ship Length (Class 5)	: 150-200	:m
Ship Length (Class 6)	: 200-250	:m
Ship Length (Class 7)	: 250-300	:m
Ship Length (Class 8)	: 300-350	:m
Ship Length (Class 9)	: 350-400	:m
Ship Length (Class 10)	: > 400	:m
Reference	: Coastal Martina-LR=6.5	

MAMPEC - Result Sheet-Small Marina –Leaching Rate=9.3 µg /cm^2/day

Run : Default marina-Swiss marina 1 Copper Omadine (default) Default Marina 100% Cu-Omadine-9.3
Version : MamPec 2.0
Run date : 11/4/2008 1:57:41 PM
Memo :

Input
Environment : Default marina-Swiss marina 1
Compound : Copper Omadine (default)
Emission : Default Marina 100% Cu-Omadine-9.3
Load : 1.40E+02:g/d

Results

Total concentration in water

Maximum concentration	: 1.56E+00	:ug/l
95 % concentration	: 1.56E+00	:ug/l
Average concentration	: 9.81E-01	:ug/l
Median concentration	: 9.12E-01	:ug/l
Minimum concentration	: 3.17E-01	:ug/l

Dissolved concentration in water

Maximum concentration	: 1.54E+00	:ug/l
95 % concentration	: 1.54E+00	:ug/l
Average concentration	: 9.69E-01	:ug/l
Median concentration	: 9.01E-01	:ug/l
Minimum concentration	: 3.13E-01	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 4.39E-01	:ug/g dw
95 % concentration	: 4.39E-01	:ug/g dw
Average concentration	: 2.77E-01	:ug/g dw
Median concentration	: 2.57E-01	:ug/g dw
Minimum concentration	: 8.95E-02	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 1.84E-06	:ug/g dw
95 % concentration	: 1.84E-06	:ug/g dw
Average concentration	: 1.16E-06	:ug/g dw
Median concentration	: 1.08E-06	:ug/g dw
Minimum concentration	: 3.75E-07	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 1.84E-06	:ug/g dw
95 % concentration	: 1.84E-06	:ug/g dw
Average concentration	: 1.16E-06	:ug/g dw
Median concentration	: 1.08E-06	:ug/g dw
Minimum concentration	: 3.75E-07	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 1.84E-06	:ug/g dw
95 % concentration	: 1.84E-06	:ug/g dw
Average concentration	: 1.16E-06	:ug/g dw
Median concentration	: 1.08E-06	:ug/g dw
Minimum concentration	: 3.75E-07	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 1.84E-06	:ug/g dw
95 % concentration	: 1.84E-06	:ug/g dw
Average concentration	: 1.16E-06	:ug/g dw
Median concentration	: 1.08E-06	:ug/g dw
Minimum concentration	: 3.75E-07	:ug/g dw

Results in surrounding waters

Total concentration in water

Maximum concentration	: 6.20E-02	:ug/l
95 % concentration	: 6.04E-02	:ug/l
Average concentration	: 5.84E-03	:ug/l
Median concentration	: 3.63E-02	:ug/l
Minimum concentration	: 2.66E-02	:ug/l

Dissolved concentration in water

Maximum concentration	: 6.12E-02	:ug/l
95 % concentration	: 5.96E-02	:ug/l
Average concentration	: 5.77E-03	:ug/l
Median concentration	: 3.58E-02	:ug/l
Minimum concentration	: 2.63E-02	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 1.75E-02	:ug/g dw
95 % concentration	: 1.70E-02	:ug/g dw
Average concentration	: 1.65E-03	:ug/g dw
Median concentration	: 1.02E-02	:ug/g dw
Minimum concentration	: 7.51E-03	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 7.34E-08	:ug/g dw
95 % concentration	: 7.14E-08	:ug/g dw
Average concentration	: 6.91E-09	:ug/g dw
Median concentration	: 4.29E-08	:ug/g dw
Minimum concentration	: 3.15E-08	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 7.34E-08	:ug/g dw
95 % concentration	: 7.14E-08	:ug/g dw
Average concentration	: 6.91E-09	:ug/g dw
Median concentration	: 4.29E-08	:ug/g dw
Minimum concentration	: 3.15E-08	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 7.34E-08	:ug/g dw
95 % concentration	: 7.14E-08	:ug/g dw
Average concentration	: 6.91E-09	:ug/g dw
Median concentration	: 4.29E-08	:ug/g dw
Minimum concentration	: 3.15E-08	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 7.34E-08	:ug/g dw
95 % concentration	: 7.14E-08	:ug/g dw
Average concentration	: 6.91E-09	:ug/g dw
Median concentration	: 4.29E-08	:ug/g dw
Minimum concentration	: 3.15E-08	:ug/g dw

MAMPEC - Input data sheet

Compound

Name	:	Copper-pyrithione	
Description	:	Copper Omadine (default)	
Molecular mass	:	315.85	:g/Mol
Vapor pressure	:	5.00E-07	:Pa
Solubility	:	6.00E-02	:g/m3
Octanol-water coefficient	:	2.44E+00	:(-) Log (Kow)
Kd	:	0.00E+00	:m3/kg
Koc	:	4.00E+00	:(-) Log(Koc), Koc expressed as l/kg OrganicCarbon
Henry's coefficient	:	2.60E-03	:Pa.m3/mol
Melting temperature	:	0.0	:oC
pKa	:	0.0	:(-)
in water			
Biological degradation rate	:	1.76E-01	:1/d
Hydrolytic degradation rate	:	3.82E-02	:1/d
Photolytic degradation rate	:	9.20E-01	:1/d
in sediment			
Biological degradation rate	:	6.30E-01	:1/d
Hydrolytic degradation rate	:	8.13E+00	:1/d
Photolytic degradation rate	:	0.00E+00	:1/d
Advanced Photodegradation calculation	:	False	
Reference	:		

Environment

Description	: Default marina-Swiss marina 1	
Silt concentration	: 35.0	:g/m3
Particular organic carbon conc	: 1.0	:g Organic Carbon/m3
Dissolved organic carbon conc	: 2.0	:g/m3
Temperature	: 25.0	:oC
Salinity	: 5.00E+00	:s.e.
Depth well-mixed sediment top layer	: 1.00E-01	: m
Sediment density	: 1.000E+03	:kg/m3
Fraction organic carbon in sediment	: 3.00E-02	:-/-
Nett sedimentation velocity	: 1.00E-01	:m/d
pH	: 6.5	:(-)

Chlorophyll	: 3.00	:ug/l
Latitude	: 50.00	degrees NH
Background concentrations	: 0.00E+00	:ug/l
Average windspeed	: 0.00	:m/s
Fraction wind perpendicular to harbour	: 0.00	:-/-
Daily maximum non tidal water level change	: 0.00	:m
Length of river, not part of harbor (x1)	: 100	:m
Width of harbor (y1)	: 100	:m
Length of harbor (x2)	: 100	:m
Width of river (y2)	: 100	:m
Depth of harbor	: 2	:m
Length of open harbour mouth (x3)	: 30	:m
Flow	: 0.1	:m/s
Flow of flushing into harbor	: 0	:m3/s
Tidal height	: 1	:m
Density difference	: 0.1	:kg/m3
Density difference flushing	: 0	:kg/m3
Tidal period	: 12.41	:h
Exchange surface	: 60	:m2
Depth at harbour mouth	: 2	:m
Height underwater dam at mouth	: 0	:m
Width underwater dam at mouth	: 0	:m
Length selected area	: 0	:m
Width selected area	: 0	:m
Depth selected area	: 0	:m
Flow	: 0	:m/s
Exchange volume in 1 tidal period	: 15383	:m3
Reference	:	This is a Swiss Marina scenario taken from OECD 2005 report

Emission

Description	: Default Marina 100% Cu-Omadine-9.3	
Load	: 139.5	:g/d
Loading due to moving ships	: 0	:g/d
Loading due to ships at berth	: 139.5	:g/d
Leaching rate ships at berth	: 9.3	:ug/cm2/d
Leaching rate ships at berth	: 9.3	:ug/cm2/d
Number of ships at berth (Class 1)	: 75	
Number of ships at berth (Class 2)	: 0	
Number of ships at berth (Class 3)	: 0	
Number of ships at berth (Class 4)	: 0	
Number of ships at berth (Class 5)	: 0	
Number of ships at berth (Class 6)	: 0	
Number of ships at berth (Class 7)	: 0	
Number of ships at berth (Class 8)	: 0	
Number of ships at berth (Class 9	: 0	
Number of ships at berth (Class 10)	: 0	
Number of moving ships (Class 1)	: 0	
Number of moving ships (Class 2)	: 0	
Number of moving ships (Class 3)	: 0	
Number of moving ships (Class 4)	: 0	
Number of moving ships (Class 5)	: 0	
Number of moving ships (Class 6)	: 0	
Number of moving ships (Class 7)	: 0	
Number of moving ships (Class 8)	: 0	

Number of moving ships (Class 9)	: 0	
Number of moving ships (Class 10)	: 0	
Application factor (Class 1)	: 100	:%
Application factor (Class 2)	: 100	:%
Application factor (Class 3)	: 100	:%
Application factor (Class 4)	: 100	:%
Application factor (Class 5)	: 100	:%
Application factor (Class 6)	: 20	:%
Application factor (Class 7)	: 20	:%
Application factor (Class 8)	: 20	:%
Application factor (Class 9)	: 20	:%
Application factor (Class 10)	: 20	:%
Underwater ship area (Class 1)	: 20	:m2
Underwater ship area (Class 2)	: 22.5	:m2
Underwater ship area (Class 3)	: 450	:m2
Underwater ship area (Class 4)	: 3061	:m2
Underwater ship area (Class 5)	: 5999	:m2
Underwater ship area (Class 6)	: 9917	:m2
Underwater ship area (Class 7)	: 14814	:m2
Underwater ship area (Class 8)	: 22645	:m2
Underwater ship area (Class 9)	: 27547	:m2
Underwater ship area (Class 10)	: 39668	:m2
Ship Length (Class 1)	: 0-10	:m
Ship Length (Class 2)	: 10-50	:m
Ship Length (Class 3)	: 50-100	:m
Ship Length (Class 4)	: 100-150	:m
Ship Length (Class 5)	: 150-200	:m
Ship Length (Class 6)	: 200-250	:m
Ship Length (Class 7)	: 250-300	:m
Ship Length (Class 8)	: 300-350	:m
Ship Length (Class 9)	: 350-400	:m
Ship Length (Class 10)	: > 400	:m
Reference	: Coastal Martina-LR=9.3	

Appendix C

Inputs, parameters and out put results from the MAMPEC Model run for Scenario 3

MAMPEC - Result Sheet-Coastal Marina- Leaching rate=6.5 µg /cm^2/day

Run : Default marina for salt water Copper Omadine (default) Default Marina 100% Cu-Omadine
Version : MamPec 2.0
Run date : 11/4/2008 11:08:23 AM
Memo :

Input
Environment : Default marina for salt water
Compound : Copper Omadine (default)
Emission : Default Marina 100% Cu-Omadine
Load : 4.37E+02:g/d

Results

Total concentration in water

Maximum concentration	: 2.86E-01	:ug/l
95 % concentration	: 2.76E-01	:ug/l
Average concentration	: 1.88E-01	:ug/l
Median concentration	: 1.86E-01	:ug/l
Minimum concentration	: 3.96E-02	:ug/l

Dissolved concentration in water

Maximum concentration	: 2.82E-01	:ug/l
95 % concentration	: 2.72E-01	:ug/l
Average concentration	: 1.85E-01	:ug/l
Median concentration	: 1.84E-01	:ug/l
Minimum concentration	: 3.91E-02	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 8.07E-02	:ug/g dw
95 % concentration	: 7.77E-02	:ug/g dw
Average concentration	: 5.30E-02	:ug/g dw
Median concentration	: 5.25E-02	:ug/g dw
Minimum concentration	: 1.12E-02	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 1.69E-06	:ug/g dw
95 % concentration	: 1.63E-06	:ug/g dw
Average concentration	: 1.11E-06	:ug/g dw
Median concentration	: 1.10E-06	:ug/g dw
Minimum concentration	: 2.34E-07	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 1.69E-06	:ug/g dw
95 % concentration	: 1.63E-06	:ug/g dw
Average concentration	: 1.11E-06	:ug/g dw
Median concentration	: 1.10E-06	:ug/g dw
Minimum concentration	: 2.34E-07	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 1.69E-06	:ug/g dw
95 % concentration	: 1.63E-06	:ug/g dw
Average concentration	: 1.11E-06	:ug/g dw
Median concentration	: 1.10E-06	:ug/g dw
Minimum concentration	: 2.34E-07	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 1.69E-06	:ug/g dw
95 % concentration	: 1.63E-06	:ug/g dw
Average concentration	: 1.11E-06	:ug/g dw
Median concentration	: 1.10E-06	:ug/g dw
Minimum concentration	: 2.34E-07	:ug/g dw

Results in surrounding waters

Total concentration in water

Maximum concentration	: 1.70E-02	:ug/l
95 % concentration	: 1.47E-02	:ug/l
Average concentration	: 9.15E-04	:ug/l
Median concentration	: 7.58E-03	:ug/l
Minimum concentration	: 6.45E-03	:ug/l

Dissolved concentration in water

Maximum concentration	: 1.65E-02	:ug/l
95 % concentration	: 1.45E-02	:ug/l
Average concentration	: 9.03E-04	:ug/l
Median concentration	: 7.49E-03	:ug/l
Minimum concentration	: 6.37E-03	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 4.70E-03	:ug/g dw
95 % concentration	: 4.14E-03	:ug/g dw
Average concentration	: 2.58E-04	:ug/g dw
Median concentration	: 2.14E-03	:ug/g dw
Minimum concentration	: 1.82E-03	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 9.86E-08	:ug/g dw
95 % concentration	: 8.68E-08	:ug/g dw
Average concentration	: 5.41E-09	:ug/g dw
Median concentration	: 4.49E-08	:ug/g dw
Minimum concentration	: 3.81E-08	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 9.86E-08	:ug/g dw
95 % concentration	: 8.68E-08	:ug/g dw
Average concentration	: 5.41E-09	:ug/g dw
Median concentration	: 4.49E-08	:ug/g dw
Minimum concentration	: 3.81E-08	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 9.86E-08	:ug/g dw
95 % concentration	: 8.68E-08	:ug/g dw
Average concentration	: 5.41E-09	:ug/g dw
Median concentration	: 4.49E-08	:ug/g dw
Minimum concentration	: 3.81E-08	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 9.86E-08	:ug/g dw
95 % concentration	: 8.68E-08	:ug/g dw
Average concentration	: 5.41E-09	:ug/g dw
Median concentration	: 4.49E-08	:ug/g dw
Minimum concentration	: 3.81E-08	:ug/g dw

MAMPEC - Input data sheet

Compound

Name	:	Copper-pyrithione	
Description	:	Copper Omadine (default)	
Molecular mass	:	315.85	:g/Mol
Vapor pressure	:	5.00E-07	:Pa
Solubility	:	6.00E-02	:g/m3
Octanol-water coefficient	:	2.44E+00	:(-) Log (Kow)
Kd	:	0.00E+00	:m3/kg
Koc	:	4.00E+00	:(-) Log(Koc), Koc expressed as l/kg OrganicCarbon
Henry's coefficient	:	2.60E-03	:Pa.m3/mol
Melting temperature	:	0.0	:oC
pKa	:	0.0	:(-)
in water			
Biological degradation rate	:	1.76E-01	:1/d
Hydrolytic degradation rate	:	3.82E-02	:1/d
Photolytic degradation rate	:	9.20E-01	:1/d
in sediment			
Biological degradation rate	:	6.30E-01	:1/d
Hydrolytic degradation rate	:	8.13E+00	:1/d
Photolytic degradation rate	:	0.00E+00	:1/d
Advanced Photodegradation calculation	:	False	
Reference	:		

Environment

Description	: Default marina for salt water	
Silt concentration	: 35.0	:g/m3
Particular organic carbon conc	: 1.0	:g Organic Carbon/m3
Dissolved organic carbon conc	: 2.0	:g/m3
Temperature	: 25.0	:oC
Salinity	: 3.40E+01	:s.e.
Depth well-mixed sediment top layer	: 1.00E-01	: m
Sediment density	: 1.000E+03	:kg/m3
Fraction organic carbon in sediment	: 3.00E-02	:-/-
Nett sedimentation velocity	: 5.00E-01	:m/d

pH	: 8.0	:(-)
Chlorophyll	: 3.00	:ug/l
Latitude	: 50.00 degrees NH	
Background concentrations	: 0.00E+00	:ug/l
Average windspeed	: 0.00	:m/s
Fraction wind perpendicular to harbour	: 0.00	:-/-
Daily maximum non tidal water level change	: 0.00	:m
Length of river, not part of harbor (x1)	: 400	:m
Width of harbor (y1)	: 400	:m
Length of harbor (x2)	: 400	:m
Width of river (y2)	: 400	:m
Depth of harbor	: 3.5	:m
Length of open harbour mouth (x3)	: 100	:m
Flow	: 1	:m/s
Flow of flushing into harbor	: 0	:m3/s
Tidal height	: 1	:m
Density difference	: 0.1	:kg/m3
Density difference flushing	: 0	:kg/m3
Tidal period	: 12.41	:h
Exchange surface	: 350	:m2
Depth at harbour mouth	: 3.5	:m
Height underwater dam at mouth	: 0	:m
Width underwater dam at mouth	: 0	:m
Length selected area	: 0	:m
Width selected area	: 0	:m
Depth selected area	: 0	:m
Flow	: 0	:m/s
Exchange volume in 1 tidal period	: 243420	:m3
Reference	:	

Emission

Description	: Default Marina 100% Cu-Omadine	
Load	: 437.2875	:g/d
Loading due to moving ships	: 0	:g/d
Loading due to ships at berth	: 437.2875	:g/d
Leaching rate ships at berth	: 6.5	:ug/cm2/d
Leaching rate ships at berth	: 6.5	:ug/cm2/d
Number of ships at berth (Class 1)	: 0	
Number of ships at berth (Class 2)	: 299	
Number of ships at berth (Class 3)	: 0	
Number of ships at berth (Class 4)	: 0	
Number of ships at berth (Class 5)	: 0	
Number of ships at berth (Class 6)	: 0	
Number of ships at berth (Class 7)	: 0	
Number of ships at berth (Class 8)	: 0	
Number of ships at berth (Class 9	: 0	
Number of ships at berth (Class 10)	: 0	
Number of moving ships (Class 1)	: 0	
Number of moving ships (Class 2)	: 0	
Number of moving ships (Class 3)	: 0	
Number of moving ships (Class 4)	: 0	
Number of moving ships (Class 5)	: 0	
Number of moving ships (Class 6)	: 0	
Number of moving ships (Class 7)	: 0	

Number of moving ships (Class 8)	: 0	
Number of moving ships (Class 9)	: 0	
Number of moving ships (Class 10)	: 0	
Application factor (Class 1)	: 100	:%
Application factor (Class 2)	: 100	:%
Application factor (Class 3)	: 100	:%
Application factor (Class 4)	: 100	:%
Application factor (Class 5)	: 100	:%
Application factor (Class 6)	: 20	:%
Application factor (Class 7)	: 20	:%
Application factor (Class 8)	: 20	:%
Application factor (Class 9)	: 20	:%
Application factor (Class 10)	: 20	:%
Underwater ship area (Class 1)	: 20	:m2
Underwater ship area (Class 2)	: 22.5	:m2
Underwater ship area (Class 3)	: 450	:m2
Underwater ship area (Class 4)	: 3061	:m2
Underwater ship area (Class 5)	: 5999	:m2
Underwater ship area (Class 6)	: 9917	:m2
Underwater ship area (Class 7)	: 14814	:m2
Underwater ship area (Class 8)	: 22645	:m2
Underwater ship area (Class 9)	: 27547	:m2
Underwater ship area (Class 10)	: 39668	:m2
Ship Length (Class 1)	: 0-10	:m
Ship Length (Class 2)	: 10-50	:m
Ship Length (Class 3)	: 50-100	:m
Ship Length (Class 4)	: 100-150	:m
Ship Length (Class 5)	: 150-200	:m
Ship Length (Class 6)	: 200-250	:m
Ship Length (Class 7)	: 250-300	:m
Ship Length (Class 8)	: 300-350	:m
Ship Length (Class 9)	: 350-400	:m
Ship Length (Class 10)	: > 400	:m
Reference	: Coastal Martina-LR=6.5	

MAMPEC - Result Sheet-Coastal Marina-Leaching rate=9.3 µg /cm^2/day

Run : Default marina-Swiss marina 1 Copper Omadine (default) Default Marina 100% Cu-Omadine-9.3
Version : MamPec 2.0
Run date : 11/4/2008 2:18:20 PM
Memo :

Input
Environment : Default marina
Compound : Copper Omadine (default)
Emission : Default Marina 100% Cu-Omadine 9.3
Load : 6.26E+02:g/d

Results

Total concentration in water

Maximum concentration	: 4.18E-01	:ug/l
95 % concentration	: 4.03E-01	:ug/l
Average concentration	: 2.76E-01	:ug/l
Median concentration	: 2.74E-01	:ug/l
Minimum concentration	: 5.83E-02	:ug/l

Dissolved concentration in water

Maximum concentration	: 4.13E-01	:ug/l
95 % concentration	: 3.98E-01	:ug/l
Average concentration	: 2.72E-01	:ug/l
Median concentration	: 2.71E-01	:ug/l
Minimum concentration	: 5.76E-02	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 1.18E-01	:ug/g dw
95 % concentration	: 1.14E-01	:ug/g dw
Average concentration	: 7.78E-02	:ug/g dw
Median concentration	: 7.74E-02	:ug/g dw
Minimum concentration	: 1.64E-02	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 2.48E-06	:ug/g dw
95 % concentration	: 2.38E-06	:ug/g dw
Average concentration	: 1.63E-06	:ug/g dw
Median concentration	: 1.62E-06	:ug/g dw
Minimum concentration	: 3.45E-07	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 2.48E-06	:ug/g dw
95 % concentration	: 2.38E-06	:ug/g dw
Average concentration	: 1.63E-06	:ug/g dw
Median concentration	: 1.62E-06	:ug/g dw
Minimum concentration	: 3.45E-07	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 2.48E-06	:ug/g dw
95 % concentration	: 2.38E-06	:ug/g dw
Average concentration	: 1.63E-06	:ug/g dw
Median concentration	: 1.62E-06	:ug/g dw
Minimum concentration	: 3.45E-07	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 2.48E-06	:ug/g dw
95 % concentration	: 2.38E-06	:ug/g dw
Average concentration	: 1.63E-06	:ug/g dw
Median concentration	: 1.62E-06	:ug/g dw
Minimum concentration	: 3.45E-07	:ug/g dw

Results in surrounding waters

Total concentration in water

Maximum concentration	: 2.46E-02	:ug/l
95 % concentration	: 2.16E-02	:ug/l
Average concentration	: 1.35E-03	:ug/l
Median concentration	: 1.12E-02	:ug/l
Minimum concentration	: 9.51E-03	:ug/l

Dissolved concentration in water

Maximum concentration	: 2.43E-02	:ug/l
95 % concentration	: 2.14E-02	:ug/l
Average concentration	: 1.33E-03	:ug/l
Median concentration	: 1.11E-02	:ug/l
Minimum concentration	: 9.39E-03	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 6.94E-03	:ug/g dw
95 % concentration	: 6.10E-03	:ug/g dw
Average concentration	: 3.81E-04	:ug/g dw
Median concentration	: 3.16E-03	:ug/g dw
Minimum concentration	: 2.68E-03	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 1.46E-07	:ug/g dw
95 % concentration	: 1.28E-07	:ug/g dw
Average concentration	: 7.99E-09	:ug/g dw
Median concentration	: 6.62E-08	:ug/g dw
Minimum concentration	: 5.63E-08	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 1.46E-07	:ug/g dw
95 % concentration	: 1.28E-07	:ug/g dw
Average concentration	: 7.99E-09	:ug/g dw
Median concentration	: 6.62E-08	:ug/g dw
Minimum concentration	: 5.63E-08	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 1.46E-07	:ug/g dw
95 % concentration	: 1.28E-07	:ug/g dw
Average concentration	: 7.99E-09	:ug/g dw
Median concentration	: 6.62E-08	:ug/g dw
Minimum concentration	: 5.63E-08	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 1.46E-07	:ug/g dw
95 % concentration	: 1.28E-07	:ug/g dw
Average concentration	: 7.99E-09	:ug/g dw
Median concentration	: 6.62E-08	:ug/g dw
Minimum concentration	: 5.63E-08	:ug/g dw

MAMPEC - Input data sheet

Compound

Name	:	Copper-pyrithione	
Description	:	Copper Omadine (default)	
Molecular mass	:	315.85	:g/Mol
Vapor pressure	:	5.00E-07	:Pa
Solubility	:	6.00E-02	:g/m3
Octanol-water coefficient	:	2.44E+00	:(-) Log (Kow)
Kd	:	0.00E+00	:m3/kg
Koc	:	4.00E+00	:(-) Log(Koc), Koc expressed as l/kg OrganicCarbon
Henry's coefficient	:	2.60E-03	:Pa.m3/mol
Melting temperature	:	0.0	:oC
pKa	:	0.0	:(-)
in water			
Biological degradation rate	:	1.76E-01	:1/d
Hydrolytic degradation rate	:	3.82E-02	:1/d
Photolytic degradation rate	:	9.20E-01	:1/d
in sediment			
Biological degradation rate	:	6.30E-01	:1/d
Hydrolytic degradation rate	:	8.13E+00	:1/d
Photolytic degradation rate	:	0.00E+00	:1/d
Advanced Photodegradation calculation	:	False	
Reference	:		

Environment

Description	: Default marina	
Silt concentration	: 35.0	:g/m3
Particular organic carbon conc	: 1.0	:g Organic Carbon/m3
Dissolved organic carbon conc	: 2.0	:g/m3
Temperature	: 20.0	:oC
Salinity	: 3.40E+01	:s.e.
Depth well-mixed sediment top layer	: 1.00E-01	: m
Sediment density	: 1.000E+03	:kg/m3
Fraction organic carbon in sediment	: 3.00E-02	:-/-
Nett sedimentation velocity	: 5.00E-01	:m/d
pH	: 8.0	:(-)

Chlorophyll	: 3.00	:ug/l
Latitude	: 50.00	degrees NH
Background concentrations	: 0.00E+00	:ug/l
Average windspeed	: 0.00	:m/s
Fraction wind perpendicular to harbour	: 0.00	:-/-
Daily maximum non tidal water level change	: 0.00	:m
Length of river, not part of harbor (x1)	: 400	:m
Width of harbor (y1)	: 400	:m
Length of harbor (x2)	: 400	:m
Width of river (y2)	: 400	:m
Depth of harbor	: 3.5	:m
Length of open harbour mouth (x3)	: 100	:m
Flow	: 1	:m/s
Flow of flushing into harbor	: 0	:m3/s
Tidal height	: 1	:m
Density difference	: 0.1	:kg/m3
Density difference flushing	: 0	:kg/m3
Tidal period	: 12.41	:h
Exchange surface	: 350	:m2
Depth at harbour mouth	: 3.5	:m
Height underwater dam at mouth	: 0	:m
Width underwater dam at mouth	: 0	:m
Length selected area	: 0	:m
Width selected area	: 0	:m
Depth selected area	: 0	:m
Flow	: 0	:m/s
Exchange volume in 1 tidal period	: 243420	:m3
Reference	:	

Emission

Description	: Default Marina 100% Cu-Omadine 9.3	
Load	: 625.6575	:g/d
Loading due to moving ships	: 0	:g/d
Loading due to ships at berth	: 625.6575	:g/d
Leaching rate ships at berth	: 9.3	:ug/cm2/d
Leaching rate ships at berth	: 9.3	:ug/cm2/d
Number of ships at berth (Class 1)	: 0	
Number of ships at berth (Class 2)	: 299	
Number of ships at berth (Class 3)	: 0	
Number of ships at berth (Class 4)	: 0	
Number of ships at berth (Class 5)	: 0	
Number of ships at berth (Class 6)	: 0	
Number of ships at berth (Class 7)	: 0	
Number of ships at berth (Class 8)	: 0	
Number of ships at berth (Class 9	: 0	
Number of ships at berth (Class 10)	: 0	
Number of moving ships (Class 1)	: 0	
Number of moving ships (Class 2)	: 0	
Number of moving ships (Class 3)	: 0	
Number of moving ships (Class 4)	: 0	
Number of moving ships (Class 5)	: 0	
Number of moving ships (Class 6)	: 0	
Number of moving ships (Class 7)	: 0	
Number of moving ships (Class 8)	: 0	
Number of moving ships (Class 9)	: 0	

Number of moving ships (Class 10)	: 0	
Application factor (Class 1)	: 100	:%
Application factor (Class 2)	: 100	:%
Application factor (Class 3)	: 100	:%
Application factor (Class 4)	: 100	:%
Application factor (Class 5)	: 100	:%
Application factor (Class 6)	: 20	:%
Application factor (Class 7)	: 20	:%
Application factor (Class 8)	: 20	:%
Application factor (Class 9)	: 20	:%
Application factor (Class 10)	: 20	:%
Underwater ship area (Class 1)	: 20	:m2
Underwater ship area (Class 2)	: 22.5	:m2
Underwater ship area (Class 3)	: 450	:m2
Underwater ship area (Class 4)	: 3061	:m2
Underwater ship area (Class 5)	: 5999	:m2
Underwater ship area (Class 6)	: 9917	:m2
Underwater ship area (Class 7)	: 14814	:m2
Underwater ship area (Class 8)	: 22645	:m2
Underwater ship area (Class 9)	: 27547	:m2
Underwater ship area (Class 10)	: 39668	:m2
Ship Length (Class 1)	: 0-10	:m
Ship Length (Class 2)	: 10-50	:m
Ship Length (Class 3)	: 50-100	:m
Ship Length (Class 4)	: 100-150	:m
Ship Length (Class 5)	: 150-200	:m
Ship Length (Class 6)	: 200-250	:m
Ship Length (Class 7)	: 250-300	:m
Ship Length (Class 8)	: 300-350	:m
Ship Length (Class 9)	: 350-400	:m
Ship Length (Class 10)	: > 400	:m
Reference	: Coastal Martina-LR=9.3	

Appendix D

Inputs, parameters and out put results from the MAMPEC Model run for Scenario 4

MAMPEC - Result Sheet-Coastal Harbor-LR=6.5 µg /cm^2/day

Run : Default estuarine harbour 1 Copper Omadine (default) Default Estuarine Harbour-1
Version : MamPec 2.0
Run date : 11/4/2008 11:15:33 AM
Memo :

Input
Environment : Default estuarine harbour 1
Compound : Copper Omadine (default)
Emission : Default Estuarine Harbour-1
Load : 6.29E+03:g/d

Results

Total concentration in water

Maximum concentration	: 6.76E-02	:ug/l
95 % concentration	: 6.24E-02	:ug/l
Average concentration	: 3.34E-02	:ug/l
Median concentration	: 2.56E-02	:ug/l
Minimum concentration	: 4.95E-03	:ug/l

Dissolved concentration in water

Maximum concentration	: 6.68E-02	:ug/l
95 % concentration	: 6.16E-02	:ug/l
Average concentration	: 3.30E-02	:ug/l
Median concentration	: 2.53E-02	:ug/l
Minimum concentration	: 4.89E-03	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 1.91E-02	:ug/g dw
95 % concentration	: 1.76E-02	:ug/g dw
Average concentration	: 9.42E-03	:ug/g dw
Median concentration	: 7.23E-03	:ug/g dw
Minimum concentration	: 1.40E-03	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 4.00E-07	:ug/g dw
95 % concentration	: 3.69E-07	:ug/g dw
Average concentration	: 1.98E-07	:ug/g dw
Median concentration	: 1.52E-07	:ug/g dw
Minimum concentration	: 2.93E-08	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 4.00E-07	:ug/g dw
95 % concentration	: 3.69E-07	:ug/g dw
Average concentration	: 1.98E-07	:ug/g dw
Median concentration	: 1.52E-07	:ug/g dw
Minimum concentration	: 2.93E-08	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 4.00E-07	:ug/g dw
95 % concentration	: 3.69E-07	:ug/g dw
Average concentration	: 1.98E-07	:ug/g dw
Median concentration	: 1.52E-07	:ug/g dw
Minimum concentration	: 2.93E-08	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 4.00E-07	:ug/g dw
95 % concentration	: 3.69E-07	:ug/g dw
Average concentration	: 1.98E-07	:ug/g dw
Median concentration	: 1.52E-07	:ug/g dw
Minimum concentration	: 2.93E-08	:ug/g dw

Results in surrounding waters

Total concentration in water

Maximum concentration	: 1.10E-02	:ug/l
95 % concentration	: 9.36E-03	:ug/l
Average concentration	: 2.29E-03	:ug/l
Median concentration	: 4.83E-03	:ug/l
Minimum concentration	: 2.59E-03	:ug/l

Dissolved concentration in water

Maximum concentration	: 1.09E-02	:ug/l
95 % concentration	: 9.24E-03	:ug/l
Average concentration	: 2.26E-03	:ug/l
Median concentration	: 4.77E-03	:ug/l
Minimum concentration	: 2.55E-03	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 3.11E-03	:ug/g dw
95 % concentration	: 2.64E-03	:ug/g dw
Average concentration	: 6.47E-04	:ug/g dw
Median concentration	: 1.36E-03	:ug/g dw
Minimum concentration	: 7.29E-04	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 6.53E-08	:ug/g dw
95 % concentration	: 5.54E-08	:ug/g dw
Average concentration	: 1.36E-08	:ug/g dw
Median concentration	: 2.86E-08	:ug/g dw
Minimum concentration	: 1.53E-08	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 6.53E-08	:ug/g dw
95 % concentration	: 5.54E-08	:ug/g dw
Average concentration	: 1.36E-08	:ug/g dw
Median concentration	: 2.86E-08	:ug/g dw
Minimum concentration	: 1.53E-08	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 6.53E-08	:ug/g dw
95 % concentration	: 5.54E-08	:ug/g dw
Average concentration	: 1.36E-08	:ug/g dw
Median concentration	: 2.86E-08	:ug/g dw
Minimum concentration	: 1.53E-08	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 6.53E-08	:ug/g dw
95 % concentration	: 5.54E-08	:ug/g dw
Average concentration	: 1.36E-08	:ug/g dw
Median concentration	: 2.86E-08	:ug/g dw
Minimum concentration	: 1.53E-08	:ug/g dw

MAMPEC - Input data sheet

Compound

Name	:	Copper-pyrithione	
Description	:	Copper Omadine (default)	
Molecular mass	:	315.85	:g/Mol
Vapor pressure	:	5.00E-07	:Pa
Solubility	:	6.00E-02	:g/m3
Octanol-water coefficient	:	2.44E+00	:(-) Log (Kow)
Kd	:	0.00E+00	:m3/kg
Koc	:	4.00E+00	:(-) Log(Koc), Koc expressed as l/kg OrganicCarbon
Henry's coefficient	:	2.60E-03	:Pa.m3/mol
Melting temperature	:	0.0	:oC
pKa	:	0.0	:(-)
in water			
Biological degradation rate	:	1.76E-01	:1/d
Hydrolytic degradation rate	:	3.82E-02	:1/d
Photolytic degradation rate	:	9.20E-01	:1/d
in sediment			
Biological degradation rate	:	6.30E-01	:1/d
Hydrolytic degradation rate	:	8.13E+00	:1/d
Photolytic degradation rate	:	0.00E+00	:1/d
Advanced Photodegradation calculation	:	False	
Reference	:		

Environment

Description	: Default estuarine harbour 1	
Silt concentration	: 35.0	:g/m3
Particular organic carbon conc	: 1.0	:g Organic Carbon/m3
Dissolved organic carbon conc	: 2.0	:g/m3
Temperature	: 25.0	:oC
Salinity	: 3.40E+01	:s.e.
Depth well-mixed sediment top layer	: 2.00E-01	: m
Sediment density	: 1.000E+03	:kg/m3
Fraction organic carbon in sediment	: 3.00E-02	:-/-
Nett sedimentation velocity	: 1.00E+00	:m/d
pH	: 7.5	:(-)

Chlorophyll	: 3.00	:ug/l
Latitude	: 50.00	degrees NH
Background concentrations	: 0.00E+00	:ug/l
Average windspeed	: 0.00	:m/s
Fraction wind perpendicular to harbour	: 0.00	:-/-
Daily maximum non tidal water level change	: 0.00	:m
Length of river, not part of harbor (x1)	: 1000	:m
Width of harbor (y1)	: 1000	:m
Length of harbor (x2)	: 5000	:m
Width of river (y2)	: 500	:m
Depth of harbor	: 15	:m
Length of open harbour mouth (x3)	: 2500	:m
Flow	: 1	:m/s
Flow of flushing into harbor	: 0	:m3/s
Tidal height	: 1.5	:m
Density difference	: 0.4	:kg/m3
Density difference flushing	: 0	:kg/m3
Tidal period	: 12.41	:h
Exchange surface	: 37500	:m2
Depth at harbour mouth	: 15	:m
Height underwater dam at mouth	: 0	:m
Width underwater dam at mouth	: 0	:m
Length selected area	: 0	:m
Width selected area	: 0	:m
Depth selected area	: 0	:m
Flow	: 0	:m/s
Exchange volume in 1 tidal period	: 60262000	:m3
Reference	:	

Emission

Description	: Default Estuarine Harbour-1	
Load	: 6285.6365	:g/d
Loading due to moving ships	: 448.9615	:g/d
Loading due to ships at berth	: 5836.675	:g/d
Leaching rate ships at berth	: 6.5	:ug/cm2/d
Leaching rate ships at berth	: 6.5	:ug/cm2/d
Number of ships at berth (Class 1)	: 0	
Number of ships at berth (Class 2)	: 0	
Number of ships at berth (Class 3)	: 11	
Number of ships at berth (Class 4)	: 5	
Number of ships at berth (Class 5)	: 5	
Number of ships at berth (Class 6)	: 1	
Number of ships at berth (Class 7)	: 2	
Number of ships at berth (Class 8)	: 0	
Number of ships at berth (Class 9	: 0	
Number of ships at berth (Class 10)	: 0	
Number of moving ships (Class 1)	: 0	
Number of moving ships (Class 2)	: 0	
Number of moving ships (Class 3)	: 1.8	
Number of moving ships (Class 4)	: 0.4	
Number of moving ships (Class 5)	: 0.4	
Number of moving ships (Class 6)	: 0.1	
Number of moving ships (Class 7)	: 0.1	
Number of moving ships (Class 8)	: 0	
Number of moving ships (Class 9)	: 0	

Number of moving ships (Class 10)	: 0		
Application factor (Class 1)	: 0	:%	
Application factor (Class 2)	: 100	:%	
Application factor (Class 3)	: 100	:%	
Application factor (Class 4)	: 100	:%	
Application factor (Class 5)	: 100	:%	
Application factor (Class 6)	: 100	:%	
Application factor (Class 7)	: 100	:%	
Application factor (Class 8)	: 100	:%	
Application factor (Class 9)	: 100	:%	
Application factor (Class 10)	: 100	:%	
Underwater ship area (Class 1)	: 20	:m2	
Underwater ship area (Class 2)	: 120	:m2	
Underwater ship area (Class 3)	: 450	:m2	
Underwater ship area (Class 4)	: 3061	:m2	
Underwater ship area (Class 5)	: 5999	:m2	
Underwater ship area (Class 6)	: 9917	:m2	
Underwater ship area (Class 7)	: 14814	:m2	
Underwater ship area (Class 8)	: 22645	:m2	
Underwater ship area (Class 9)	: 27547	:m2	
Underwater ship area (Class 10)	: 39668	:m2	
Ship Length (Class 1)	: 0-10	:m	
Ship Length (Class 2)	: 10-50	:m	
Ship Length (Class 3)	: 50-100		:m
Ship Length (Class 4)	: 100-150	:m	
Ship Length (Class 5)	: 150-200	:m	
Ship Length (Class 6)	: 200-250	:m	
Ship Length (Class 7)	: 250-300	:m	
Ship Length (Class 8)	: 300-350	:m	
Ship Length (Class 9)	: 350-400	:m	
Ship Length (Class 10)	: > 400	:m	
Reference	:		

MAMPEC - Result Sheet-Coastal Harbor-LR=9.3 µg /cm^2/day

Run : Default estuarine harbour 1 Copper Omadine (default) Default Estuarine Harbour-2
Version : MamPec 2.0
Run date : 11/4/2008 11:17:25 AM
Memo :

Input
Environment : Default estuarine harbour 1
Compound : Copper Omadine (default)
Emission : Default Estuarine Harbour-2
Load : 8.99E+03:g/d

Results

Total concentration in water

Maximum concentration	: 9.68E-02	:ug/l
95 % concentration	: 8.93E-02	:ug/l
Average concentration	: 4.78E-02	:ug/l
Median concentration	: 3.67E-02	:ug/l
Minimum concentration	: 7.09E-03	:ug/l

Dissolved concentration in water

Maximum concentration	: 9.55E-02	:ug/l
95 % concentration	: 8.81E-02	:ug/l
Average concentration	: 4.72E-02	:ug/l
Median concentration	: 3.62E-02	:ug/l
Minimum concentration	: 7.00E-03	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 2.73E-02	:ug/g dw
95 % concentration	: 2.52E-02	:ug/g dw
Average concentration	: 1.35E-02	:ug/g dw
Median concentration	: 1.03E-02	:ug/g dw
Minimum concentration	: 2.00E-03	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 5.72E-07	:ug/g dw
95 % concentration	: 5.28E-07	:ug/g dw
Average concentration	: 2.83E-07	:ug/g dw
Median concentration	: 2.17E-07	:ug/g dw
Minimum concentration	: 4.19E-08	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 5.72E-07	:ug/g dw
95 % concentration	: 5.28E-07	:ug/g dw
Average concentration	: 2.83E-07	:ug/g dw
Median concentration	: 2.17E-07	:ug/g dw
Minimum concentration	: 4.19E-08	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 5.72E-07	:ug/g dw

95 % concentration	: 5.28E-07	:ug/g dw
Average concentration	: 2.83E-07	:ug/g dw
Median concentration	: 2.17E-07	:ug/g dw
Minimum concentration	: 4.19E-08	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 5.72E-07	:ug/g dw
95 % concentration	: 5.28E-07	:ug/g dw
Average concentration	: 2.83E-07	:ug/g dw
Median concentration	: 2.17E-07	:ug/g dw
Minimum concentration	: 4.19E-08	:ug/g dw

Results in surrounding waters

Total concentration in water

Maximum concentration	: 1.60E-02	:ug/l
95 % concentration	: 1.34E-02	:ug/l
Average concentration	: 3.28E-03	:ug/l
Median concentration	: 6.91E-03	:ug/l
Minimum concentration	: 3.70E-03	:ug/l

Dissolved concentration in water

Maximum concentration	: 1.56E-02	:ug/l
95 % concentration	: 1.32E-02	:ug/l
Average concentration	: 3.24E-03	:ug/l
Median concentration	: 6.82E-03	:ug/l
Minimum concentration	: 3.65E-03	:ug/l

Contaminant concentration on suspended solids

Maximum concentration	: 4.45E-03	:ug/g dw
95 % concentration	: 3.78E-03	:ug/g dw
Average concentration	: 9.25E-04	:ug/g dw
Median concentration	: 1.95E-03	:ug/g dw
Minimum concentration	: 1.04E-03	:ug/g dw

Contaminant concentration in sediment after 1 year of use

Maximum concentration	: 9.34E-08	:ug/g dw
95 % concentration	: 7.92E-08	:ug/g dw
Average concentration	: 1.94E-08	:ug/g dw
Median concentration	: 4.09E-08	:ug/g dw
Minimum concentration	: 2.19E-08	:ug/g dw

Contaminant concentration in sediment after 2 years of use

Maximum concentration	: 9.34E-08	:ug/g dw
95 % concentration	: 7.92E-08	:ug/g dw
Average concentration	: 1.94E-08	:ug/g dw
Median concentration	: 4.09E-08	:ug/g dw
Minimum concentration	: 2.19E-08	:ug/g dw

Contaminant concentration in sediment after 5 years of use

Maximum concentration	: 9.34E-08	:ug/g dw
95 % concentration	: 7.92E-08	:ug/g dw
Average concentration	: 1.94E-08	:ug/g dw
Median concentration	: 4.09E-08	:ug/g dw
Minimum concentration	: 2.19E-08	:ug/g dw

Contaminant concentration in sediment after 10 years of use

Maximum concentration	: 9.34E-08	:ug/g dw
95 % concentration	: 7.92E-08	:ug/g dw
Average concentration	: 1.94E-08	:ug/g dw
Median concentration	: 4.09E-08	:ug/g dw
Minimum concentration	: 2.19E-08	:ug/g dw

MAMPEC - Input data sheet

Compound

Name	:	Copper-pyrithione	
Description	:	Copper Omadine (default)	
Molecular mass	:	315.85	:g/Mol
Vapor pressure	:	5.00E-07	:Pa
Solubility	:	6.00E-02	:g/m3
Octanol-water coefficient	:	2.44E+00	:(-) Log (Kow)
Kd	:	0.00E+00	:m3/kg
Koc	:	4.00E+00	:(-) Log(Koc), Koc expressed as l/kg OrganicCarbon
Henry's coefficient	:	2.60E-03	:Pa.m3/mol
Melting temperature	:	0.0	:oC
pKa	:	0.0	:(-)
in water			
Biological degradation rate	:	1.76E-01	:1/d
Hydrolytic degradation rate	:	3.82E-02	:1/d
Photolytic degradation rate	:	9.20E-01	:1/d
in sediment			
Biological degradation rate	:	6.30E-01	:1/d
Hydrolytic degradation rate	:	8.13E+00	:1/d
Photolytic degradation rate	:	0.00E+00	:1/d
Advanced Photodegradation calculation	:	False	
Reference	:		

Environment

Description	: Default estuarine harbour 1	
Silt concentration	: 35.0	:g/m3
Particular organic carbon conc	: 1.0	:g Organic Carbon/m3
Dissolved organic carbon conc	: 2.0	:g/m3
Temperature	: 25.0	:oC
Salinity	: 3.40E+01	:s.e.
Depth well-mixed sediment top layer	: 2.00E-01	: m
Sediment density	: 1.000E+03	:kg/m3
Fraction organic carbon in sediment	: 3.00E-02	:-/-
Nett sedimentation velocity	: 1.00E+00	:m/d
pH	: 7.5	:(-)
Chlorophyll	: 3.00	:ug/l

Latitude	: 50.00 degrees NH	
Background concentrations	: 0.00E+00	:ug/l
Average windspeed	: 0.00	:m/s
Fraction wind perpendicular to harbour	: 0.00	:-/-
Daily maximum non tidal water level change	: 0.00	:m
Length of river, not part of harbor (x1)	: 1000	:m
Width of harbor (y1)	: 1000	:m
Length of harbor (x2)	: 5000	:m
Width of river (y2)	: 500	:m
Depth of harbor	: 15	:m
Length of open harbour mouth (x3)	: 2500	:m
Flow	: 1	:m/s
Flow of flushing into harbor	: 0	:m3/s
Tidal height	: 1.5	:m
Density difference	: 0.4	:kg/m3
Density difference flushing	: 0	:kg/m3
Tidal period	: 12.41	:h
Exchange surface	: 37500	:m2
Depth at harbour mouth	: 15	:m
Height underwater dam at mouth	: 0	:m
Width underwater dam at mouth	: 0	:m
Length selected area	: 0	:m
Width selected area	: 0	:m
Depth selected area	: 0	:m
Flow	: 0	:m/s
Exchange volume in 1 tidal period	: 60262000	:m3
Reference	:	

Emission

Description	: Default Estuarine Harbour-2	
Load	: 8993.2953	:g/d
Loading due to moving ships	: 642.3603	:g/d
Loading due to ships at berth	: 8350.935	:g/d
Leaching rate ships at berth	: 9.3	:ug/cm2/d
Leaching rate ships at berth	: 9.3	:ug/cm2/d
Number of ships at berth (Class 1)	: 0	
Number of ships at berth (Class 2)	: 0	
Number of ships at berth (Class 3)	: 11	
Number of ships at berth (Class 4)	: 5	
Number of ships at berth (Class 5)	: 5	
Number of ships at berth (Class 6)	: 1	
Number of ships at berth (Class 7)	: 2	
Number of ships at berth (Class 8)	: 0	
Number of ships at berth (Class 9	: 0	
Number of ships at berth (Class 10)	: 0	
Number of moving ships (Class 1)	: 0	
Number of moving ships (Class 2)	: 0	
Number of moving ships (Class 3)	: 1.8	
Number of moving ships (Class 4)	: 0.4	
Number of moving ships (Class 5)	: 0.4	
Number of moving ships (Class 6)	: 0.1	
Number of moving ships (Class 7)	: 0.1	
Number of moving ships (Class 8)	: 0	
Number of moving ships (Class 9)	: 0	
Number of moving ships (Class 10)	: 0	

Application factor (Class 1)	: 0	:%	
Application factor (Class 2)	: 100	:%	
Application factor (Class 3)	: 100	:%	
Application factor (Class 4)	: 100	:%	
Application factor (Class 5)	: 100	:%	
Application factor (Class 6)	: 100	:%	
Application factor (Class 7)	: 100	:%	
Application factor (Class 8)	: 100	:%	
Application factor (Class 9)	: 100	:%	
Application factor (Class 10)	: 100	:%	
Underwater ship area (Class 1)	: 20	:m2	
Underwater ship area (Class 2)	: 120	:m2	
Underwater ship area (Class 3)	: 450	:m2	
Underwater ship area (Class 4)	: 3061	:m2	
Underwater ship area (Class 5)	: 5999	:m2	
Underwater ship area (Class 6)	: 9917	:m2	
Underwater ship area (Class 7)	: 14814	:m2	
Underwater ship area (Class 8)	: 22645	:m2	
Underwater ship area (Class 9)	: 27547	:m2	
Underwater ship area (Class 10)	: 39668	:m2	
Ship Length (Class 1)	: 0-10	:m	
Ship Length (Class 2)	: 10-50	:m	
Ship Length (Class 3)	: 50-100		:m
Ship Length (Class 4)	: 100-150	:m	
Ship Length (Class 5)	: 150-200	:m	
Ship Length (Class 6)	: 200-250	:m	
Ship Length (Class 7)	: 250-300	:m	
Ship Length (Class 8)	: 300-350	:m	
Ship Length (Class 9)	: 350-400	:m	
Ship Length (Class 10)	: > 400	:m	
Reference	:		

Sign-off Date : 11/18/10
DP Barcode No. : D384160